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ABSTRACT

This paper reports the results from one of a series of related, collaborative studies carried out in Sandy Bay, Tasmania, Australia, in 1979 and 1980, examining how young children acquire the skills to represent and solve addition and subtraction problems. The purpose of this study was to relate children's cognitive processing capabilities and their grade level to performance on addition and subtraction test items. Two sets of data were used to assess memory capacity and cognitive processing capacities. Six groups of children were then identified with different specific cognitive characteristics. A sample of children in five classes at Grades 1, 2, and 3 was selected and a set of addition and subtraction problems was administered on three occasions. Items were scored correct or incorrect, and data were summarized for each administration by grade and cognitive level. Differences were found for specific objectives, for instruction over time, and for grade level. Importantly, children who differed in cognitive processing capacity consistently performed differently regardless of other salient factors. (Author/JM)

Working Paper No. 325

PERFORMANCE ON ADDITION AND SUBTRACTION PROBLEMS: RESULTS FROM ACHIEVEMENT MONITORING TESTS--SANDY BAY STUDY

by

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Report from the Program on
Student Diversity and School Processes

The Research Committee of
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Abstract

This paper reports the results of the fourth of a series of collaborative studies examining how young children acquire the skills to represent and solve addition and subtraction problems. The purpose of this study was to relate children's cognitive processing capabilities and their grade level to their performance on a basic set of addition and subtraction test items.

From two sets of data which assessed memory capacity and cognitive processing capacities, we identified six groups of children with different specific cognitive characteristics. A sample of children in five classes at Grades 1, 2, and 3 was selected and administered a set of addition and subtraction problems on three occasions. The items were scored correct or incorrect, and data were summarized for each administration by grade and cognitive level.

There were important variations due to specific objectives, to instruction over time, and to grade. However, what is clear is that children who differ in cognitive processing capacity consistently performed differently regardless of the other important factors.

This paper reports the results from one of a series of related, collaborative studies carried out in Sandy Bay, Tasmania, Australia, in 1979 and 1980. In those studies, we examined how young children acquire the skills to represent and solve a variety of verbal addition and subtraction problems. We assumed that the evolution of children's performance on addition and subtraction tasks must be related both to their cognitive abilities and to their engagement in related instructional activities. The purpose of the study reported in this paper was to relate the children's cognitive capacity and their grade level to their performance on a standard set of items related to addition and subtraction.

The Collaborative Studies

This series of studies was jointly funded by the Research Committee of the Graduate School at the University of Wisconsin, the University of Wisconsin Center for Education Research, and the University of Tasmania. The principal investigators of the studies brought different backgrounds and skills to this collaborative effort. The identification of cognitive abilities grows out of Professor Collis' extensive work in cognitive development (for example, see Collis & Biggs, 1979). The classroom engagement ideas stem from Professor Romberg's research on teaching (see Romberg, Small, & Carnahan, 1979).

The strategy adopted for the sequence of collaborative studies has five steps:

1. Identify "M-space" for a population of children of ages 4-8.

2. Identify "cognitive processing capabilities" for the same set of children.

3. From (1) and (2) identify sets of children with different specific cognitive characteristics.

4. From (3) identify a sample of children and observe their engagement in instructional activities on related tasks for three months.

5. Measure, on three occasions over the three-month period, the sample children's performance and note the strategies they use with addition and subtraction problems.

This procedure was designed to allow us to relate performance at a given time (in terms of level achieved and strategy adopted) to the child's cognitive capability and to the specific set of instructional activities the child has been engaged with. In this way, we can consider various questions about change in performance and strategy and their possible causes.

This Study

The importance of knowing how children learn the procedures of addition and subtraction should be self-evident. Also, it is frequently assumed that children must first master those computational skills and then begin to solve addition and subtraction problems. However it has been clearly demonstrated that children develop a

variety of strategies for solving mathematical problems independent of instruction (c.f., Ginsburg, 1977; Resnick, 1978; Carpenter & Moser, 1979). In fact, many of the strategies they use are more sophisticated and demonstrate more insight than the procedures that are taught. This finding raises questions about the relationships of children's instructional experience and their capacity to their performance and their selection of strategies.

A sample of children from two schools in Sandy Bay who had been examined in the previous studies in this series (Romberg & Collis, 1980a; 1980b; Romberg, Collis, & Buchanan, 1981) were administered a set of items on three occasions over a three- to four-month period in 1980 (February 29, April 11, and May 28 or July 6). In each administration a set of test items was given to each student. Each child's performance on all items was marked. This report presents the data from those test administrations.

Cognitive Capacity

To identify children with differing cognitive capacities, a three-step procedure was followed. First, we identified memory capacity (M-space) for a population of children of ages 4-8 (Romberg & Collis, 1980a). Four M-space tests were administered.

Second, we identified cognitive processing capabilities for the same set of children (Romberg & Collis, 1980b). Fifteen different tests were given. From a factor analysis of those scores, a quantitative

factor, a qualitative correspondence factor, and a logical reasoning factor were identified.

Third, from both sets of data, we identified six groups of children with different specific cognitive characteristics. A cluster analysis procedure was used to group the children.

Cognitive Level 1 children operate at M-space Level 1, are capable of handling qualitative comparisons and transformations at a moderate level, and are incapable of dealing with quantitative tasks or logical reasoning. Cognitive Level 2 children operate at M-space Level 2, handle qualitative correspondence tasks, and cannot handle quantitative and logical skills (but were considerably better than Group 1 on all tasks). Cognitive Level 3 children also operate at M-space Level 2, are high on qualitative correspondence, have developed the specific skills of counting on and counting back, are inadequate in their use of those counting skills on transitive reasoning, and are inadequate on logical reasoning. Cognitive Level 4 children operate at M-space Level 3, are high on qualitative correspondence and all the quantitative tests, but are inadequate on the logical reasoning test. Cognitive Levels 5 and 6 are at M-space Levels 3 and 4. They reach the ceiling on the qualitative correspondence tests, have very high scores on all the quantitative tests, and also are high on logical reasoning.

Because these latter two groups were both small, included only third graders, and only differed in memory capacity, these groups have been combined for this analysis. We began with rosters of students from each grade and their cognitive level. Then an initial selection

of students was made. The students by cognitive level and grade in this study are shown in Table 1.

Description of the Tests

A battery of paper-and-pencil tests had previously been developed to monitor student achievement on addition and subtraction skills at Grades 1, 2, and 3 (Buchanan & Romberg, 1982). The battery contained three test forms for each grade. The items were written to assess the instructional objectives of ten experimental topics designed to teach addition and subtraction as well as to measure performance on certain prerequisite objectives and noninstructional objectives (Romberg, Carpenter, & Moser, 1978). A summary of all objectives included in the battery is provided in Table 2. Not all objectives were assessed at all grade levels, however; the assignment of objectives to test form (grade) is outlined below. For this study, because of the small sample of students to be tested, one of the three forms was administered at each grade (Form K at Grade 1, Form S at Grade 2, Form V at Grade 3). Copies of the tests and administrator's manuals appear in Appendix A.

Form K was a 30-minute test containing three subtests: a 15-item multiple-choice subtest and two separate 9-item subtests assessing recall of addition and subtraction facts under speeded conditions. Form S was a 35-minute test containing four subtests; three of the subtests were similar to the Form K subtests with some items dropped and some added forming a 19-item multiple-choice subtest and two 12-item recall tests. The fourth subtest was a 4-item free response sentence-

Table 1

Children at Each Cognitive Level

in Each Grade

Cognitive Level	Sandy Bay Infant School		Waimea Heights Primary School	Total
	Grade 1	Grade 2	Grade 3	
1	3	2	0	5
2	3	5	4	13
3	1	2	7	10
4	0	0	6	8
5,6	0	0	6	6
Total	7	9	23	

Table 2

Objectives Assessed in Addition and Subtraction

Achievement Monitoring Battery

Prerequisite Instructional Objectives

- Numerousness
  - 0-10
  - 11-20
  - 0-99, writes
  - 0-99, represents
- Ordering, Place Value
  - sets, one-to-one correspondence
  - numbers 0-20
  - numbers 0-99, orders
  - numbers 0-99, notation

Instructional Objectives for the S and A Topic Series

- Open Sentences
  - add 0-20
  - subt 0-20
- Sentence-Writing 0-20
  - add-simple joining
  - subt-simple separating
  - subt-part part whole-addend
  - add-part part whole
  - subt-comparison
  - subt-join-addend
- Sentence-Writing 0-99
  - add-simple joining
  - subt-simple separating
  - subt-part part whole-addend
  - add-part part whole
  - subt-comparison
  - subt-join-addend
- Algorithms
  - add 0-99
  - subt 0-99

Non-instructional Objectives

- Problem-Solving 0-20
  - add-simple joining
  - subt-simple separating
  - subt-part part whole-addend
  - add-part part whole
  - subt-comparison
  - subt-join-addend
- Problem-Solving 0-99
  - add-simple joining
  - subt-simple separating
  - subt-part part whole-addend
  - add-part part whole
  - subt-comparison
  - subt-join-addend
- Counting 9-31
  - on
  - back
- Basic Facts--Speeded Test
  - add 0-20
  - subt 0-20
- Algorithms--Timed Test
  - add 0-99
  - subt 0-99

writing measure. Form V for third grade was a 40-minute test containing six subtests. In this case the two recall subtests and the sentence-writing subtest were identical to the Form S subtests. Five items were dropped from the Form S multiple-choice subtest leaving 14 items. The two new subtests were 24-item timed measures of performance on addition and subtraction algorithms.

Multiple-choice subtests. An outline of the content of the multiple-choice subtest for each grade is given In Table 3. Individual objectives in the areas of numerousness, ordering, place value, open sentences, and algorithms were represented by one multiple-choice item in each test form on which they were assessed. (Not all objectives were assessed at all grades.) For the two objectives for counting, counting on and counting back for numbers to 18, there was one item per form; however, an additional counting item for numbers to 31 was included in each test because information on these numbers was of potential interest relative to interview problem situations using larger items.

Four individual objectives for sentence-writing were represented by a multiple-choice item in each form. For Grade 1 these items contained numbers 5-9 or 11-15; for Grades 2 and 3 the number domains were 11-15 and 0-99. Since there was no way in a multiple-choice format to have students actually write a sentence, the items required listening to a verbal problem read aloud and then choosing the sentence which correctly represented the verbal situation. The problem situation itself was not printed on the test page. This prevented reading

Table 3

Item Content of Multiple-Choice Subtests

Item Label[1]	Form K (Grade 1)	Form S (Grade 2)	Form V (Grade 3)
C	Numerousness 0-10	Numerousness writes 0-99	Numerousness writes 0-99
D	Numerousness 11-20	Numerousness represents 0-99	Numerousness represents 0-99
E	Open Sentences add 0-10	Open Sentences add 0-10	Problem-Solving 0-20 subt-comparison 11-15
F	Open Sentences subt 11-18	Open Sentences subt 11-18	Problem-Solving 0-99 add-part part whole 0-99
G	Problem-Solving 0-20 subt-comparison 11-15	Problem-Solving 0-20 subt-comparison 11-15	Problem-Solving 0-20 subt-part part whole-addend 11-15
H	Problem-Solving 0-20 add-part part whole 5-9	Problem-Solving 0-99 add-part part whole 0-99	Problem-Solving 0-99 subt-join-addend 0-99
I	Ordering sets, one-to-one correspondence	Ordering, Place Value ordering 0-99	Ordering, Place Value ordering 0-99
J	Ordering numbers 0-20	Ordering, Place Value place value 0-99	Ordering, Place Value place value 0-99
K	Sentence-Wrting 0-20 subt-comparison 5-9	Sentence Writing 0-20 subt-simple separating 11-15	Sentence Writing 0-20 subt-simple separating 11-15
L	Sentence-Writing 0-20 subt-simple separating 11-15	Sentence-Writing 0-99 subt-comparison 0-99	Sentence-Writing 0-99 subt-comparison 0-99
M	Sentence-Writing 0-20 add-simple joining 11-15	Sentence-Writing 0-20 subt-part part whole-addend 11-15	Sentence-Writing 0-20 subt-part part whole-addend 11-15

N	Sentence-Writing 0-20 subt-part part whole-addend 11-15	Sentence-Writing 0-99 add-simple joining 0-99	Sentence-Writing 0-99 add-simple joining 0-99
O	Counting on 9-18	Problem-Solving 0-20 subt-part part whole-addend 11-15	Algorithms add 0-99
P	Counting back 9-18	Problem-Solving 0-99 subt-join-addend 0-99	Algorithms subt 0-99
Q	Counting on 18-31	Algorithms add 0-99	
R		Algorithms subt 0-99	
S		Counting on 9-18	
T		Counting back 9-18	
U		Counting on 18-31	

[1]Items A and B are samples.

difficulties and also was in keeping with the procedures for the interviews in which the problems were presented orally.

For Form K two objectives for the problem-solving area were assessed while for Forms S and V four objectives were included. The number domains were the same as for the sentence-writing objectives and, again, the problem situations were not printed in the student booklets.

All of the questions in the multiple-choice section of the tests were read to the children and then the key phrases were repeated; in the case of the verbal problems for the sentence-writing and problem-solving objectives, the entire story situation was read twice. The children then marked an X on one of the four response choices: the solution, two distractors, and the "puzzled face," an option which indicated "I have not learned this yet." The response choices, symbols, and pictures were not read or explained to the children (with the exception of the "puzzled face").

The "puzzled face" option was provided to avoid unnecessary frustration and to reduce the amount of random guessing. Although it was expected that the "puzzled face" choice would be used throughout the achievement testing because there would always be objectives not yet introduced and/or mastered, this option was particularly useful at the baseline period. Marking the "puzzled face" allowed children to give a positive response indicating that they hadn't yet learned to find the answer to the question.

Speeded subtests. There were 9 addition and 9 subtraction facts on Form K and 12 on each of Forms S and V. The first six problems in

each case covered the facts from 4 to 9; the last three (or six) involved 10 to 18 (see Table 4). The addition and subtraction recall subtests were introduced by the test administrator; then specific directions on a tape recording preceded the items presented with intervals of 4 seconds' working time for Form K and 2 seconds' for Form S and V. The children wrote their answers in designated spaces, leaving spaces for unknown facts empty. There was a short break between the two subtests.

Sentence-writing free response subtests. Four of the 12 individual sentence-writing objectives (verbal problem types) for the numbers 0-20 and 0-99 were assessed in Forms S and V. A free response format was employed in which a verbal problem was read twice to the students who were directed to write a sentence for the situation and not solve the sentence. There were two 0-20 and two 0-99 items per test. Table 5 provides an outline of the subtest items.

Addition and subtraction algorithms timed subtests. These subtests, in Form V only, each contained 24 items. The items were either 2-digit or 3-digit; 18 items required regrouping, 6 did not. The items were arranged in order of difficulty (see Table 6). For example, 3-digit problems not requiring regrouping preceded 3-digit problems which required regrouping and, for 3-digit regrouping problems, those in which only the ones were regrouped preceded those in which both ones and tens were regrouped. The students were instructed to try each problem in order (the problems were alphabetized) and to go on to the next problem if unable to do a particular example. Six minutes was allowed for each subtest.

Table 4

Addition and Subtraction Facts Recall Items--

Speeded Subtests, Forms K, S, and V

(Grades 1, 2, and 3)

Addition Facts Recall Subtests	Subtraction Facts Recall Subtests
3 + 1	7 - 1
2 + 5	8 - 4
1 + 6	9 - 5
7 + 2	7 - 4
2 + 6	8 - 6
3 + 5	4 - 3
4 + 8	11 - 2
3 + 7	13 - 8
5 + 9	12 - 7
6 + 8 [a]	15 - 9 [a]
8 + 7	10 - 2
4 + 9	16 - 7

[a]The last three items in each subtest do not appear in Form K.

Table 5

Item Content of Sentence-Writing Free Response

Subtest Forms S and V

(Grades 2 and 3)

Item Label	Content
A	Sentence-Writing 0-20 add-part part whole 11-15
B	Sentence-Writing 0-99 subt-simple separating 0-99
C	Sentence-Writing 0-99 subt-part part whole-addend 0-99
D	Sentence-Writing 0-20 subt-join-addend 11-15

Table 6

Item Content of Addition and Subtraction Algorithms--Timed Subtests Form V

(Grade 3)

Type of Problem	Number of Items
Addition Subtest	
2-digit without regrouping	3
3-digit without regrouping	3
2-digit with regrouping	6[a]
3-digit with regrouping	9
2-digit with regrouping, 3 addends	3
Subtraction Subtest	
2-digit without regrouping	3
3-digit without regrouping	3
2-digit with regrouping	6[a]
3-digit with regrouping	12

[a]Three of the 6 items are 2-digit $\pm$ 1-digit.

Test Administration

Guidelines for administering the achievement tests were provided to each of the three assistants (see Appendix B). The guidelines indicated which tests were to be given, dates for administration, and so forth.

The first administration was supervised by Professor Romberg and went smoothly. The second and third administrations were carried out after Professor Romberg had returned to the U.S. These test administrations at Grade 1 went smoothly as scheduled. At Grade 2 one item on Form S did not copy well so students could not read that question. At Grade 3 there were two administrative mixups. First, Form S rather than Form V was given in April to all three classes and in May to two of the classes. This is not a serious problem since many items are the same, except that the timed algorithms tests were not given. Second, in the third class Form V was given in July rather than May. The May administration was scheduled for near the end of the autumn term, but the assistant failed to administer the tests at that time. After a short break, children returned to school to start the winter term. The assistant asked whether she should still gather the data and was advised to administer Form V in July. The results of this administration would not reflect a lot of additional instruction since there was a break between terms. All data were then shipped to Madison and scored by Center staff. A record of each subject's response to the items was compiled from the test forms. These profiles are the basis for all summary information appearing in this paper.

Data Aggregation and Analysis

The data gathered in this study have been summarized in terms of percent correct with respect to grades and cognitive level.

Grade. The percent correct for students at Grade 1 on the items (i.e., individual objectives) and composite objectives for each of the three administrations is shown in Table 7. Overall, the data show that this sample of students at the start of the school year (February) had acquired the prerequisite objectives and could solve the verbal addition problems (but probably not by addition), and some (43%) could find the answer to an open addition problem. They could not solve subtraction problems, write sentences, count on or count back, nor could they recall basic facts.

By the end of the autumn term (May), addition skills of these students had improved dramatically. Percent correct improved for solving an open sentence, 43% to 86%; writing a correct addition sentence, 29% to 57%; counting on, 29% to 57%; and addition facts, 33% to 76%. However, the same cannot be said for subtraction. Only for solving a verbal comparison problem (29% to 71%) and for subtraction facts (29% to 56%) was there marked improvement.

For Grade 2 the picture is somewhat different (see Table 8). Overall for this sample of nine students, at the beginning of the school year the percent correct was quite low. In fact, on only three items did more that half of the students get the correct answer. Part of the difficulty was that Form S used large numbers (0-99) in several of the questions. By May improvement on several composite objectives was

Table 7

Percent Correct for Objectives and Composite Objectives by

Administration Time for Grade 1, Form K

Description of Objectives	Results for Objectives				Results for Composite Objectives			
	Number of Items	Feb. N=7	April N=7	May N=7	Number of Items	Feb. N=7	April N=7	May N=7
Prerequisite Instructional Objectives								
Numerousness								
0-10	1	100	100	100				
11-20	1	71	43	86	2	86	71	93
Ordering								
sets, one-to-one correspondence	1	86	71	86				
numbers 0-20	1	100	100	86	2	93	86	86
Instructional Objectives for S Topics								
Open Sentences								
add 0-20	1	43	57	86				
subt 0-20	1	14	14	14	2	29	36	50
Sentence-Writing 0-20								
subt-simple separating (11-15)	1	14	0	0				
subt-comparison (5-9)	1	29	14	0				
add-simple joining (11-15)	1	29	14	57				
subt-part part whole-addend (11-15)	1	14	14	29	4	21	11	21
Noninstructional Objectives								
Problem Solving 0-20								
add-part part whole (5-9)	1	100	100	100				
subt-comparison (11-15)	1	29	14	71	2	64	57	86
Counting On 9-31	2	29	43	57				
Counting Back 9-31	1	0	14	14	3	19	33	43
Recall of Basic Facts--Speeded Test								
add 0-20					9	33	49	76
subt 0-20					9	29	44	56

Table 8

Percent Correct for Objectives and Composite Objectives by

Administration Time for Grade 2, Form S

Description of Objectives	Results for Objectives				Results for Composite Objectives			
	Number of Items	Feb. N=9	April N=9	May N=8	Number of Items	Feb. N=9	April N=9	May N=8
Prerequisite Instructional Objectives								
Numerousness								
writes 0-99	1	--	--	--[a]				
represents 0-99	1	56	67	75	1	56	67	75
Ordering, Place Value								
ordering 0-99	1	11	0	25				
place value 0-99	1	0	0	13	2	6	0	19
Instructional Objectives for S and A Topics								
Open Sentences								
add 0-20	1	22	78	100				
subt 0-20	1	11	0	75	2	17	39	88
Sentence-Writing 0-20, 0-99 (multiple choice)								
subt-simple separating (11-15)	1	33	33	25				
subt-comparison (0-99)	1	0	0	0				
add-simple joining (0-99)	1	11	11	25				
subt-part part whole-addend (11-15)	1	22	11	13	4	17	14	16
Sentence-Writing 0-20, 0-99 (free response)								
subt-simple separating (0-99)	1	56	44	75				
subt-part part whole-addend (0-99)	1	0	0	0				
add-part part whole (11-15)	1	56	89	100				
subt-join-addend (11-15)	1	0	78	63	4	28	53	59
Algorithms								
addition algorithm	1	11	33	13				
subtraction algorithm	1	11	0	38	2	11	17	25

continued

Table 8 (continued)

Description of Objectives	Results for Objectives				Results for Composite Objectives			
	Number of Items	Feb. N=9	April N=9	May N=8	Number of Items	Feb. N=9	April N=9	May N=8
Noninstructional Objectives								
Problem-Solving 0-20, 0-99								
add-part part whole (0-99)	1	0	22	25				
subt-comparison (11-15)	1	22	56	50				
subt-part part whole-addend (11-15)	1	44	67	13				
subt-join-addend (0-99)	1	22	11	13	4	22	39	25
Counting On 9-31	2	33	28	81				
Counting Back 9-31	1	22	44	25	3	30	33	63
Recall of Basic Facts--Speeded Test								
add 0-20					12	29	35	51
subt 0-20					12	23	30	53

[a]Students were unable to complete item because tests duplicated poorly.

apparent. The students were comfortable with numerousness of larger sets (56% to 75%), had improved on basic facts (29% to 51% and 23% to 53%, but not yet to any level of mastery), could solve simple open sentences (17% to 88%), and had improved in counting (30% to 63%) and writing sentences for verbal problems (28% to 59%). But increases in performance were not apparent for ordering large numbers, problem solving, selecting written sentences for verbal problems, and algorithms.

For the Grade 3 students, the picture was more encouraging (see Table 9). In February, their performance was not high (above 80%) except on two items, but by the end of May (or early July) performance on all composite objectives except one was approaching or about 80%. The one exception was the item on place value for numbers 0-99. Sentence writing-selecting skills had improved, but for some subtraction situations (comparison and part-part-whole addend) scores were not yet high.

Performance of the Grade 3 students on the timed algorithms test is shown in Table 10. In February when all 22 children were tested, they performed well on the six addition-without-regrouping problems and fair on the three items testing 2-digit subtraction without regrouping. On all others, they did poorly. Part of the difficulty was that because of the timed conditions most did not attempt the last items in the test. Those children who did reach the items did fairly well on the addition regrouping items but had considerable difficulty with the subtraction items requiring regrouping.

Table 9

Percent Correct for Objectives and Composite Objectives by Administration Time for Grade 3, Forms S, V

Description of Objectives	Results for Objectives				Results for Composite Objectives			
	Number of Items	Feb. N=22	April N=22	May/July[a] N=11/12	Number of Items	Feb. N=22	April N=22	May/July N=11/12
Prerequisite Instructional Objectives								
Numerousness								
writes 0-99	1	45	32	64/92				
represents 0-99	1	91	91	100/91	2	68	61	82/92
Ordering, Place Value								
ordering 0-99	1	36	91	64/75				
place value 0-99	1	23	50	0/42	2	30	70	32/58
Instructional Objectives for S and A Topics								
Sentence-Writing 0-20, 0-99 (multiple choice)								
subt-simple separating (11-15)	1	60	91	73/100				
subt-comparison (0-99)	1	18	14	18/58				
add-simple joining (0-99)	1	77	91	64/100				
subt-part part whole-addend (11-15)	1	10	50	9/75	4	41	61	41/83
Sentence-Writing 0-20, 0-99 (free response)								
subt-simple separating (0-99)	1	36	77	82/92				
subt-part part whole-addend (0-99)	1	5	23	18/67				
add-part part whole (11-15)	1	68	95	100/92				
subt-join-addend (11-15)	1	45	60	55/75	4	39	64	64/81

continued

Table 9 (continued)

Description of Objectives	Results for Objectives				Results for Composite Objectives			
	Number of Items	Feb. N=22	April N=22	May/July[a] N=11/12	Number of Items	Feb. N=22	April N=22	May/July N=11/12
Noninstructional Objectives								
Problem-Solving 0-20, 0-99								
add-part part whole (0-99)	1	55	68	64/92				
subt-comparison (11-15)	1	91	77	100/100				
subt-part part whole-addend (11-15)	1	77	95	91/83				
subt-join-addend (0-99)	1	45	73	64/75	4	67	78	80/87
Recall of Basic Facts--Speeded Test								
add 0-20					12	44	66	66/94
subt 0-20					12	40	69	52/84
Algorithms--Timed Test								
addition algorithm					24	41	--	--/81[b]
subtraction algorithm					24	15	--	--/65[b]

[a]Form S was used in April and May; Form V was used in February and July.

[b]Form S did not assess this objective.

Table 10

Percent Correct for Addition and Subtraction Algorithms

Timed Tests by Problem Type for Grade 3, Form V

Item Type	Number of Items	Percent Correct Feb. N=22	Percent Correct July N=12
Addition			
2-digit (without regrouping)	3	86	100
3-digit (without regrouping)	3	93	94
2-digit (with regrouping)[a]	6	49	89
3-digit (with regrouping)	9	16	78
3 2-digit addends	3	0	44
Subtraction			
2-digit (without regrouping)	3	68	94
3-digit (without regrouping)	3	33	89
2-digit (with regrouping)[a]	6	8	75
3-digit (with regrouping)	12	0	47

[a]3 items are 2-digit $\pm$ 1-digit.

Unfortunately, no children were given this test again in April or May and only 12 in July. By then performance for those students was considerably better. There was still some difficulty with the three addend addition problems and the subtraction regrouping problems but the increases in every case are striking.

Cognitive level. The relative performance on the test items for children in Grade 1 at different cognitive levels is shown in Table 11. There were three children at both cognitive level 1 and 2 but only one child at cognitive level 3. The differences in performance for the eight composite objectives favor the CL2 group over the CL1 group on six composites, with some of the differences being quite large. In addition, the CL2 students increased in performance from February to May over all the objectives but the CL1 students improved only in recall of facts (see Table C-1 in Appendix C). The single CL3 child fails to fit any pattern.

For the Grade 2 children, the relative performance for children at different cognitive levels is shown in Table 12. There were two children at cognitive levels 1 and 3 and five at level 2. In general, the pattern shows CL3 children performing better than CL2 children who in turn to better than the CL1 children. Some of the differences are striking, for example, open sentences (58%-46%-33%) and addition facts (60%-35%-24%). However, there is one anomaly. For the four problem solving items, the CL1 children did better than either other group (45% to 20% and 33%). However, since these children were low on facts, algorithms, and counting skills, the results suggest that they found

Table 11

Frequency and Percent Correct for Composite Objectives by Cognitive Level for all Administration Times for Grade 1, Form K

Objectives	Number of Items	Cognitive Level 1 N=9		Cognitive Level 2 N=9		Cognitive Level 3 N=3		Total N=21	
		f/%	trials	f/%	trials	f/%	trials	f/%	trials
Prerequisite Instructional Objectives									
Numerousness 0-20	2	14/78	18	17/94	18	4/67	6	35/83	42
Ordering 0-20	2	16/89	18	15/83	18	6/100	6	37/88	42
Instructional Objectives for the S Topics									
Open Sentences	2	7/39	18	7/39	18	2/33	6	16/38	42
Sentence-writing 0-20	4	4/11	36	9/25	36	2/17	12	15/18	84
Noninstructional Objectives									
Problem-solving 0-20	2	12/67	18	13/72	18	4/67	6	29/69	42
Counting	3	2/7	27	16/59	27	2/22	9	20/32	63
Addition Facts Recall--Speeded Test	9	24/30	81	65/80	81	11/41	27	100/53	189
Subtraction Facts Recall--Speeded Test	9	24/30	81	49/60	81	8/30	27	81/43	189

Table 12

Frequency and Percent Correct for Composite Objectives by Cognitive Level

for all Administration Times for Grade 2, Form S

Objectives	Number of Items	Cognitive Level 1 N=6		Cognitive Level 2 N=14		Cognitive Level 3 N=6		Total N=26	
		f/%	trials	f/%	trials	f/%	trials	f/%	trials
Prerequisite Instructional Objectives									
Numerousness 0-99	1[a]	4/67	6	8/58	14	5/84	6	17/67	26
Ordering, Place Value 0-99	2	3/25	12	0/0	28	1/8	12	4/8	52
Instructional Objectives for the S and A Topics									
Open Sentences	2	4/33	12	13/46	28	7/58	12	24/46	52
Sentence-writing 0-20, 0-99 (multiple choice)	4	1/4	24	11/20	56	4/17	24	16/15	104
Sentence-writing 0-20, 0-99 (free response)	4	9/38	24	25/45	56	14/58	24	48/46	104
Algorithms	2	1/8	12	4/14	28	4/33	12	9/17	52
Noninstructional Objectives									
Problem Solving 0-20, 0-99	4	11/46	24	11/20	56	8/33	24	30/29	104
Counting	3	6/33	18	14/33	42	12/67	18	32/41	78
Addition Facts Recall--Speeded Test	12	17/24	72	58/35	168	43/60	72	118/38	312
Subtraction Facts Recall--Speeded Test	12	16/22	72	50/30	168	43/60	72	109/35	312

[a]Two items were administered for the numerousness objective; students had difficulty reading one of the items due to poor quality of the test duplication so data for this item were discarded.

answers to the verbal problems using other strategies. The children with better arithmetic skills (but not close to mastery) may have attempted to use those skills to solve the problems but made errors. This explanation is further substantiated by the decrease in performance of the CL1 children on these items as the year progresses and their arithmetic skills improve (see Table C-2 in Appendix C).

For the Grade 3 students at different cognitive levels, the results are striking but somewhat ambiguous (see Table 13). The CL5-6 group performed better on all objectives that any other group, and the CL2 group was lower than other groups on all the objectives. But the CL3 and CL4 groups in between failed to differ in a consistent manner. Obviously the defining characteristics between these two groups are not related to differences in performance. Most of the differences between the CL5-6 group and the CL2 group are large (selecting sentences 65% to 44%, ordering 68% to 33%, subtraction algorithms 51% to 13%, and so forth.

Summary of Results

In summary, the picture these data presents is of children struggling to learn the complex arithmetic skills associated with addition and subtraction and to use those skills to solve verbal problems. While improvement across and within grades was apparent, the change in performance was not synchronous. Children had problems with place value even though they correctly answered 3-digit problems. Work on

Table 13

Frequency and Percent Correct for Composite Objectives by Cognitive Level

for all Administration Times for Grade 3, Forms S and V

Objectives	Number of Items	Cognitive Level 2 N=12		Cognitive Level 3 N=20		Cognitive Level 4 N=18		Cognitive Levels 5,6 N=17		Total N=67	
		f/%	trials	f/%	trials	f/%	trials	f/%	trials	f/%	trials
Prerequisite Instructional Objectives											
Numerousness 0-99	2	15/63	24	29/73	40	24/67	36	29/85	34	97/72	134
Ordering, Place Value 0-99	2	8/33	24	20/50	40	14/39	36	23/68	34	65/49	134
Instructional Objectives for the S and A Topics											
Sentence-writing 0-20, 0-99 (multiple choice)	4	21/44	48	42/53	80	39/54	72	44/65	68	146/54	268
Sentence-writing 0-20, 0-99 (free response)	4	25/52	48	49/61	80	37/51	72	44/65	68	155/58	268
Noninstructional Objectives											
Problem Solving 0-20, 0-99	4	34/71	48	58/73	80	55/76	72	58/85	68	205/76	268
Addition Algorithms--Timed Test[a]	24	30/31	96	134/51	264	111/51	216	172/72	240	447/55	816
Subtraction Algorithms--Timed Test[a]	12	12/13	96	78/30	264	55/25	216	122/51	240	267/33	816
Addition Facts Recall--Speeded Test	12	65/45	144	152/63	240	133/62	216	162/79	204	512/64	804
Subtraction Facts Recall—Speeded Test	12	61/42	144	135/56	240	126/58	216	154/75	204	476/59	804

[a]This objective was assessed in February for 22 students representing all cognitive levels (N=12, 20, 18, 17) and in May for 12 students at all levels except 2 (N=0, 4, 3, 5). It was not assessed in April.

algorithms improved even though basic facts were weak. And children correctly solved some simple verbal problems with little arithmetic competence.

With one important exception, children who were identified as being at a particular cognitive level performed differently than children in other groups. The one exception was the lack of consistent differences between groups CL3 and CL4 at Grade 3. It should be noted that the CL4 group at Grade 3 also failed to fit an overall pattern on the interview tasks (see Romberg, Collis, & Buchanan, 1981).

Overall, however, it is very apparent that children who differ in cognitive processing capacity performed differently regardless of specific objective, instruction over time, or grade.

Secondary Analyses

Upon the completion of this study, we decided to related these data to two other sets of data. First, for the third-grade children in this study, we decided to relate their performance on the timed algorithm problems to the strategies they used to solve verbal problems which could be done using those algorithms. The strategy data were collected in the interview study reported earlier (Romberg, Collis, & Buchanan, 1981).

Second, since the achievement tests (Buchanan & Romberg, 1982) were constructed for a study in the U.S., we decided to contrast the results found in this study with the U.S. data.

Strategies and performance. The question we were interested in examining was whether or not students who could use the addition and subtraction algorithms chose to use them when solving verbal problems. The strategy data on verbal problems were derived from the interview study in this sequence of studies. An interview consisted of six problem types (tasks) given under different conditions to each student. The six types included two problems solvable by addition of the two given numbers and four problems solvable by subtraction of the two given numbers. The characterization for these six problem types is detailed in Moser (1979) and in Carpenter and Moser (1979). Table 14 presents representative problems in the order in which the problems were administered to the children. The actual wording for each problem type differed in each condition, but the semantic structure remained consistent.

Within each problem, two of three numbers from a number triple (x, y, z) defined by $x + y = z$, $x < y < z$, were given. In the two addition problems x, y were presented, with the smaller number x always given first. In the four subtraction problems, z and the larger addend y were presented. The order of presentation of y and z varied among problem types.

For the interviews with third-grade children, the domain of 2-digit numbers was included. In the 2-digit domain, two subdomains were identified. In the first no regrouping (borrowing or carrying) was required to determine a difference or sum when a computational algorithm was used. In the second subdomain, regrouping was required. The no regrouping set was called the "D" problem set while the regrouping set was referred to

Table 14

Representative Problem Types

Task 1.	Joining (Addition)	Pam had 3 shells. Her brother gave her 6 more shells. How many shells did Pam have altogether?
Task 2.	Separating (Subtraction)	Jenny had 7 erasers. She gave 5 erasers to Ben. How many erasers did Jenny have left?
Task 3.	Part-Part-Whole Missing Addend (Subtraction)	There are 5 fish in a bowl. 3 are striped and the rest are spotted. How many spotted fish are in the bowl?
Task 4.	Part-Part-Whole (Addition)	Matt has 2 baseball cards. He also has 4 football cards. How many cards does Matt have altogether?
Task 5.	Comparison (Subtraction)	Angie has 4 lady bugs. Her brother Todd has 7 lady bugs. How many more lady bugs does Todd have than Angie?
Task 6.	Joining Missing Addend (Subtraction)	Gene has 5 marshmallows. How many more marshmallows does he have to put with them so he has 8 marshmallows altogether?

as the "E" problems. For the 2-digit problems, the sum z was restricted to numbers in the 20s and 30s.

A record of each subject's response to the tasks was compiled from the coding sheets. For each task, the four coded entries were model, correctness, strategy, and error. This information was then aggregated into eight independent general strategy categories for the D and E data (nonsentence/direct modeling, nonsentence/counting, nonsentence/routine mental operation, nonsentence/nonroutine mental operation, nonsentence/inappropriate, sentence/algorithm, sentence/nonalgorithm, inappropriate sentence). For this analysis the nonsentence/routine mental operations and sentence/algorithm categories were combined and contrasted with all others.

In Table 15 each child's data are presented for the addition problems requiring no regrouping. Available achievement test scores for the first administration (February) and the last (July) are reported. This is followed by whether or not each of the two verbal addition problems in the D set were done algorithmically or not. For these 23 students at time 1, 62 items were attempted and 57 were correct (92%) and in July all 36 items attempted were correct. With one exception (student 517), these students knew how to add 2-digit numbers without regrouping.

However, on the interviews at time 1, algorithms were used only 59% of the time (54% correctly). On interviews 2 and 3, the percent of use increased only to 79% and 72%.

Table 15

Performance on Achievement Test Addition Algorithm (Nonregrouping) Items and Use of Algorithmic Strategies for Interview Addition Algorithm Tasks—Level D

Cognitive Level	ID	Achievement Score 3 2-digit + 2-digit				Level D Interviews 2 Addition Tasks					
		February		July		Interview 1		Interview 2		Interview 3	
		# Attmpt.	# Corr.	# Attmpt.	# Corr.	Task 1	Task 4	Task 1	Task 4	Task 1	Task 4
2	542	3	3	-	-	✓		✓	✓C	✓	✓
	516	3	3	-	-	✓B			✓	✓	
	551	2	2	-	-				✓	✓	✓
	515	2	2	-	-	✓	✓	✓	✓		
3	531	3	3	3	3	✓	✓	✓	✓	✓	✓
	527	3	3	3	3	✓	✓	NA	NA	✓	✓
	525	3	3	-	-						
	513	3	3	3	3						
	502	2	2	3	3	✓		✓			✓
	550	3	2	-	-		✓	✓	✓	✓	✓
	541	3	2	-	-	✓	✓	NA	NA	✓	✓
4	548	3	3	-	-	✓	✓	✓	✓	✓	✓
	547	3	3	-	-	✓		✓B			
	543	3	3	3	3	✓	✓	✓	✓	✓	✓
	534	3	3	3	3			✓	✓	✓	✓
	512	2	2	3	3			✓	✓	✓	
	517	3	1	-	-	✓C	✓	✓	✓B		
5,6	528	3	3	3	3		✓	✓	✓	✓	✓
	549	3	3	3	3	✓		✓		✓	✓
	526	3	3	-	-	✓		✓	✓	✓	✓
	536	3	3	3	3	✓		✓	✓	✓	✓
	530	3	2	3	3		✓	✓	✓	✓	✓
	538	-	-	3	3	✓	✓	✓	✓	✓	✓

Key: NA = not administered
✓ = algorithmic strategy, correctly used
✓B = algorithmic strategy, "buggy" error
✓C = algorithmic strategy, computational error
✓O = algorithmic strategy, reverse operation error
✓? = algorithmic strategy, unknown error

Similar data for addition with regrouping is shown in Table 16. In this case, six achievement items (three 2-digit plus 1-digit items and three 2-digit plus 2-digit items) were administered and contrasted with the two verbal addition problems in the E set. At time 1 students attempted 95 items and got 66 correct (69%) and by time 2 they attempted 71 items getting 66 correct (90%). Thus, while there was some difficulty with regrouping at the start of the year, by July, with the exception of student 512 who made six errors in six problems, the students all could add with regrouping.

The interview data show that in spite of this level of performance, many students did not use the algorithms to solve verbal addition problems. On the interview 1 tasks, about half (54%) of the children tried using an algorithm (46% correctly). On the second interview, this had changed to 60% using an algorithm (48% correctly) and by interview 3 78% used an algorithm with no errors.

For subtraction without regrouping, performance on three achievement items is contrasted with strategies used on the four verbal subtraction problems. (See Table 17.) At time 1, 55 items had been attempted with 45 being correct (82%) and by time 2, 34 of 36 attempts were correct (94%). In fact, only one student made any errors in July. One can conclude that these students were able to subtract without regrouping. However, on the four verbal subtraction problems only 14% of the strategies used were algorithms (only 9% correct) at the start of the year. By the second interview, this had increased to 25% and

Table 16

Performance on Achievement Test Addition Algorithm (Regrouping) Items and Use of Algorithmic Strategies for Interview Addition Algorithm Tasks--Level E

Cognitive Level	ID	Achievement Score 3 2-digit + 1-digit				Achievement Score 3 2-digit + 2-digit				Level E Interviews 2 Addition Tasks					
		February		July		February		July		Interview 1		Interview 2		Interview 3	
		# Attmpt.	# Corr.	# Attmpt.	# Corr.	# Attmpt.	# Corr.	# Attmpt.	# Corr.	Task 1	Task 4	Task 1	Task 4	Task 1	Task 4
2	542	3	2	-	-	3	2	-	-	✓				✓	✓
	551	3	2	-	-	0	0	-	-				✓	✓	✓
	516	1	0	-	-	3	0	-	-					✓	✓
	515	0	0	-	-	0	0	-	-	✓		✓?	✓		
3	531	3	3	3	3	3	3	3	3	✓	✓	✓	✓	✓	✓
	550	3	3	-	-	3	2	-	-			✓		✓	
	541	0	0	-	-	3	3	-	-	✓	✓	NA	NA	✓	✓
	527	2	1	3	3	0	0	3	2	✓	✓B	NA	NA	✓	✓
	525	3	0	-	-	1	0	-	-						
	513	2	0	3	3	2	0	2	2						
	502	2	0	3	3	0	0	3	3					✓	✓
4	548	3	3	-	-	3	3	-	-	✓	✓	✓C	✓	✓	✓
	547	3	3	-	-	2	2	-	-		✓			✓	
	543	3	3	3	3	2	2	3	3	✓	✓	✓	✓	✓	✓
	517	3	3	-	-	2	0	-	-	✓B	✓B	✓C		✓	
	534	3	2	3	3	0	0	3	3			✓	✓	✓	✓
	512	1	1	3	0	0	0	3	0			✓	✓	✓	✓
5,6	5??	3	3	3	3	3	3	3	3	✓	✓	✓	✓	✓	✓
	530	3	3	3	3	3	3	3	3	✓	✓	✓	✓	✓	✓
	549	3	2	3	?	3	3	3	3	✓B	✓			✓	
	526	3	3	-	-	3	2	-	-	✓	✓	✓B	✓	✓	✓
	536	3	1	3	3	3	0	3	3			✓	✓C	✓	✓
	538	-	-	3	3	-	-	3	3	✓	✓	✓	✓	✓	✓

Key: NA = not administered
✓ = algorithmic strategy, correctly used
✓B = algorithmic strategy, "Buggy" error
✓C = algorithmic strategy, computational error
✓0 = algorithmic strategy, reverse operation error
✓? = algorithmic strategy, unknown error

Table 17

Performance on Achievement Test Subtraction Algorithm (Nonregrouping) Items and Use of Algorithmic Strategies for Interview Subtraction Algorithm Tasks--Level D

Cognitive Level	ID	Achievement Score 3 2-digit - 2 digit				Level D Interviews 4 Subtraction Tasks			
		February		July		Interview 1			
		# Attmpt.	# Corr.	# Attmpt.	# Corr.	Task 2	Task 3	Task 5	Task 6
2	515	3	3	-	-			✓	
	542	3	3	-	-	✓B	✓B		
	516	3	3	-	-				
	551	3	0	-	-				
3	531	3	3	3	3	✓	✓		✓
	550	3	3	-	-				
	502	3	3	3	3				
	525	3	3	-	-				
	513	3	3	3	1				
	527	0	0	3	3				
	541	0	0	-	-	✓	✓		
4	534	3	3	3	3				
	547	3	3	-	-	✓B			
	543	3	2	3	3	✓			
	517	2	[illegible]	-	-	✓C	✓O		
	548	1	[illegible]	-	-	✓B			
	512	1	0	3	3				
5,6	528	3	3	3	3				
	530	3	3	3	3				
	536	3	3	3	3				
	526	3	2	-	-	✓			
	549	3	2	3	3				
	538	-	-	3	3				

continued

Table 17 (continued)

Cognitive Level	ID	Level D Interviews 4 Subtraction Tasks							
		Interview 2				Interview 3			
		Task 2	Task 3	Task 5	Task 6	Task 2	Task 3	Task 5	Task 6
2	515	✓	✓						
	542					✓			
	516			✓					
	551					✓			
3	531					✓	✓	✓	
	550	✓				✓			
	502	✓		✓					
	525	✓							
	513								
	527	NA	NA	NA	NA	✓			
	541	NA	NA	NA	NA	✓	✓	✓B	
4	534					✓	✓		
	547					✓	✓		
	543	✓				✓	✓	✓	✓
	517	✓							
	548		✓				✓		
	512								
5,6	528		✓			✓	✓	✓	✓
	530	✓	✓	✓	✓	✓			
	536					✓			
	526	✓				✓			
	549	✓				✓			
	538	✓	✓	✓	✓	✓	✓	✓	✓

Key: NA = not administered
✓ = algorithmic strategy, correctly used
✓B = algorithmic strategy, "buggy" error
✓C = algorithmic strategy, computational error
✓O = algorithmic strategy, reverse operation error
✓? = algorithmic strategy, unknown error

finally to 34% by the third interview. Furthermore, over half of the total attempts (59%) were just on Task 2 (simple separate), the most obvious subtraction problem.

The same pattern, only more pronounced, occurred for the subtraction with regrouping contrast. (See Table 18.) There were six subtraction achievement problems (three 2-digit minus 1-digit items and three 2-digit minus 2-digit items). At the start of the year only 38 items were attempted and only 12 were correct (32%). Many children managed only to complete the first six no-regrouping tiems in this timed test so that we have no measure of their capability. However, while it is hard to imagine why they were so slow, one can only assume that they would have been unable to do the regrouping problems had they attempted them. However, by the second administration (July), 66 items were attempted and 54 were correct (82%). Also, only two students (502 and 513) made more than one error on the six problems. Thus, while there was evidence of considerable difficulty in subtracting with regrouping in February, by the end of the Autumn term most were capable of using a subtraction algorithm.

But again, in spite of knowing algorithmic procedures, most children did not attempt to solve verbal problems using them. On the first interview, algorithms were used on only 13% of the tiems (5% correctly). On the second interview, this had increased to 23% (11% correctly), and by the third interview, it was 35% (26% correctly). And, as with subtraction no-regrouping, most of the attempts were on the simple separating tasks (44%).

Table 18

Performance on Achievement Test Subtraction Algorithm (Regrouping) Items and Use of Algorithmic Strategies for Interview Subtraction Algorithm Tasks--Level E

Cognitive Level	ID	Achievement Score 3 2-digit - 1-digit				Achievement Score 3 2-digit - 2-digit			
		February		July		February		July	
		# Attmpt.	# Corr.	# Attmpt.	# Corr.	# Attmpt.	# Corr.	# Attmpt.	# Corr.
2	551	3	0	-	-	3	0	-	-
	542	0	0	-	-	1	0	-	-
	516	0	0	-	-	0	0	-	-
	515	0	0	-	-	0	0	-	-
3	531	3	2	3	3	0	0	3	3
	502	2	2	3	1	0	0	3	2
	527	2	2	3	3	0	0	3	3
	541	2	0	-	-	0	0	-	-
	525	0	0	-	-	0	0	-	-
	513	0	0	3	0	0	0	3	0
	550	0	0	-	-	0	0	-	-
4	543	3	0	3	3	2	0	3	3
	534	0	0	3	3	0	0	3	3
	547	0	0	-	-	0	0	-	-
	517	0	0	-	-	0	0	-	-
	548	0	0	-	-	0	0	-	-
	512	0	0	0	0	0	0	0	0
5,6	528	3	3	3	3	0	0	3	3
	549	2	2	3	3	3	0	3	2
	530	3	1	3	3	0	0	3	3
	526	3	0	-	-	3	0	-	-
	536	0	0	3	2	0	0	3	2
	538	-	-	3	3	-	-	3	3

continued

Table 18 (continued)

Cognitive Level	ID	Level E Interviews 4 Subtraction Tasks											
		Interview 1				Interview 2				Interview 3			
		Task 2	Task 3	Task 5	Task 6	Task 2	Task 3	Task 5	Task 6	Task 2	Task 3	Task 5	Task 6
2	551									✓			
	542	√B	√B						√B	✓	✓		
	516					√B				✓	✓	√C	√B
	515	√0	√B	√B			√B		√B	√C			
3	531				✓				✓	✓	√0		
	502												✓
	527					NA	NA	NA	NA	✓	√B		✓
	541					NA	NA	NA	NA	✓	✓	√B	
	525												
	513												
	550	√?				√B							
4	543					✓				✓		✓	✓
	534									✓			
	547												
	517					√B	√0	√B	√?				
	548	✓				✓	✓	✓	✓	✓			✓
	512											✓	
5,6	528			✓	✓					✓	✓		
	549					✓				√C			
	530												
	526	√0				√B				✓			
	536									√B			
	538		✓			✓			✓	✓	✓		✓

Key: NA = not administered
✓ = algorithmic strategy, correctly used
√B = algorithmic strategy, "buggy" error
√C = algorithmic strategy, computational error
√0 = algorithmic strategy, reverse operation error
√? = algorithmic strategy, unknown error

Also on this set of verbal problems, the CL2 students make the most total attempts to use algorithms (35% of the time), even though they got no items correct on the achievement test but have the most errors (only 10% correct). The CL5,6 students attempted to use algorithms 22% of the time and got 17% correct.

Overall, this relationship between skill of doing addition and subtraction algorithms and using the algorithms to solve verbal problems is interesting. These third-grade students use other strategies (counting, fingers, and so forth) until they become really confident in using the algorithms. The children who are confident in all four symbolic situations are more likely to use algorithms than children who experience some difficulty. However, the problem structures (verbal semantics) clearly influence how problems are worked.

Tasmanian vs. Wisconsin data. We were able to contrast the achievement test data gathered in Sandy Bay and somewhat comparable data from Wisconsin. There are several factors which preclude drawing firm conclusions from this comparison.

First, for Grade 1, in particular, the status of the children in the school year was different. The Wisconsin students had already had instruction for three months. Second, the Wisconsin data are based on three forms and the Tasmanian data on one form. Third, the Wisconsin data are based on all children in several classes, the Tasmanian data on a carefully selected sample. And fourth, the Wisconsin data were based on a sample of children following a specific mathematics program with the achievement tests being written to assess the effects of its

use (Romberg, Carpenter, & Moser, 1978). The Tasmanian children were being instructed in a more conventional mathematics program.

The comparable percent correct on composite objectives is shown for Grades 1, 2, and 3 in Tables 19, 20, and 21. Comparisons in those tables are shown in terms of approximately the same time in the school year. (Recall the U.S. school year starts in September, the Australian in February.)

At Grade 1 only one direct comparison is reasonable and the data indicate similar levels of performance on four composite objectives and higher performance for the Sandy Bay children on four composites.

At Grade 2 a different picture is evident. The Tasmanian children are much behind the Wisconsin Grade 2 children at the start of the year. On most objectives they show substantial improvement and nearly catch up three months later. This is probably due to instruction.

Finally, at Grade 3 the Wisconsin children perform somewhat better on most objectives than the Sandy Bay children in April and May/July. The only conclusion we are willing to draw is that the observed differences are most likely due to differential instructional emphasis.

Table 19

Percent Correct for Composite Objectives at Comparable Administration Times

for U.S. and Sandy Bay Children--Grade 1

Objective	Site	Feb.	April	Baseline May	S-1	S-2	S-3
Prerequisite Instructional Objectives							
Numerousness 0-20	U.S.	--	--	95	94	97	99
	Sandy Bay	86	71	93	--	--	--
Ordering 0-20	U.S.	--	--	85	94	95	95
	Sandy Bay	93	86	86	--	--	--
Instructional Objectives for the S Topics							
Open Sentences	U.S.	--	--	27	51	74	78
	Sandy Bay	29	36	50	--	--	--
Sentence-writing 0-20	U.S.	--	--	22	41	54	60
	Sandy Bay	21	11	21	--	--	--
Noninstructional Objectives							
Problem-solving 0-20	U.S.	--	--	63	70	76	81
	Sandy Bay	64	57	86	--	--	--
Counting	U.S.	--	--	43	42	49	52
	Sandy Bay	19	33	43	--	--	--
Addition Facts Recall--Speeded Test	U.S.	--	--	51	56	69	77
	Sandy Bay	33	49	76	--	--	--
Subtraction Facts Recall--Speeded Test	U.S.	--	--	33	44	55	65
	Sandy Bay	29	44	56	--	--	--

Table 20

Percent Correct for Composite Objectives at Comparable Administration Times

for U.S. and Sandy Bay Children--Grade 2

Objective	Site	S-4 Feb.	S-5 April	S-6 May	A-1	A-2
Prerequisite Instructional Objectives						
Numerousness 0-99	U.S.	70	76	82	87	92
	Sandy Bay	56	67	75	--	--
Ordering, Place Value 0-99	U.S.	43	47	46	54	55
	Sandy Bay	6	0	19	--	--
Instructional Objectives for the S and A Topics						
Open Sentences	U.S.	85	91	89	--	--
	Sandy Bay	17	39	88	--	--
Sentence-writing 0-20, 0-99 (multiple choice)	U.S.	59	65	69	--	--
	Sandy Bay	17	14	16	--	--
Sentence-writing 0-20, 0-99 (free response)	U.S.	65	73	77	78	75
	Sandy Bay	28	53	59	--	--
Algorithms	U.S.	41	52	52	46	62
	Sandy Bay	11	17	25	--	--
Noninstructional Objectives						
Problem-Solving 0-20, 0-99	U.S.	60	70	67	--	--
	Sandy Bay	22	39	25	--	--
Counting	U.S.	67	71	73	--	--
	Sandy Bay	30	33	63	--	--
Addition Facts Recall--Speeded Test	U.S.	63	74	79	80	81
	Sandy Bay	29	35	51	--	--
Subtraction Facts Recall--Speeded Test	U.S.	51	61	65	64	67
	Sandy Bay	23	30	54	--	--

45

Table 21

Percent Correct for Composite Objectives at Comparable Administration Times

for U.S. and Sandy Bay Children--Grade 3

Objective	Site	Feb.	A-3 April	A-4 May/July
Prerequisite Instructional Objectives				
Numerousness 0-99	U.S.	--	93	95
	Sandy Bay	68	61	82/92
Ordering, Place Value 0-99	U.S.	--	54	69
	Sandy Bay	30	70	32/58
Instructional Objectives for the S and A Topics				
Sentence-writing 0-20, 0-99 (multiple choice)	U.S.	--	85	88
	Sandy Bay	41	61	41/83
Sentence-writing 0-20, 0-99 (free response)	U.S.	--	85	90
	Sandy Bay	39	64	64/81
Noninstructional Objectives				
Problem-Solving 0-20, 0-99	U.S.	--	85	88
	Sandy Bay	67	78	80/87
Addition Algorithms--Timed Test	U.S.	--	76	86
	Sandy Bay	41	--	--/81
Subtraction Algorithms--Timed Test	U.S.	--	52	62
	Sandy Bay	15	--	--/65
Addition Facts Recall--Speeded Test	U.S.	--	91	93
	Sandy Bay	44	66	66/94
Subtraction Facts Recall--Speeded Test	U.S.	--	84	90
	Sandy Bay	40	69	52/84

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Appendix A

ACHIEVEMENT MONITORING TESTS

FORMS K, S, AND V AND DIRECTIONS

50 Directions for Administering Achievement Monitoring Test K

Coordinated Study #1

General Directions

Reading the Test. This test is read aloud to the children. Read the questions exactly as they are printed in the directions; do not paraphrase. Each question is read twice--or the key phrases are repeated after the original question is read. Read the questions at a somewhat slower than conversational pace. The second part of the test, the basic facts speed test, will be administered via tape.

Since many children will not know how to do the majority of the test, especially at the beginning of the study, they will no doubt want to ask questions or want you to repeat items yet again. Please do not allow this--instead, ask them to answer "as best they can" or to mark the "puzzled face." Note also that reading the answers to the children (with the exception of row I) is not advisable; for example, a child may ask what "28" is, or what a "+" sign is--it is considered part of the test to know (or not know) what "28" or "+" is!

Since this is a group-administered test, verbal exchanges with individual children can be distracting and interfering--try to establish a policy of not talking and not allowing the children to talk in between questions.

Should the above directions seem unnecessarily stringent, please realize that we are attempting to measure change over time and that we have very few questions on which to base this measurement. The children will take the other forms of this same test at 6 week intervals and then they will repeat the first form; hopefully each time they will be able to answer the questions more successfully.

Monitoring the Test. It is very desirable to have another adult in the room to help the children keep their places and to respond (as indicated above) to the inevitable questions. Both the test administrator, if possible, and the monitor should move about the room making sure that the children mark only one box in each row and also encouraging them to mark at least one box (the "puzzled face" if they do not know the answer). Monitoring is essential for the second part of the test, the taped basic fact items, to help the children keep their places.

Pacing the Test. Especially for the number story problems (questions G-H), it may take a "long" time for the children to figure out an answer. As a rule of thumb, allow the group to work on each question until only one or two children are still working. At that point, if necessary, suggest that anyone still working mark the "puzzled face" box. Then go on to the next question by saying "Find Row ___."

The second part of the test, the taped basic facts questions is a speed test. Once the tape is started, it will not be stopped. You will find the directions for administering this section on page ___.

Preparations for Testing

Ask the children to clear their desks except for two pencils with erasers (or a separate eraser). They will not need scratch paper for this test. The children's names have been written on the tests in advance; distribute the tests, making sure each child has his/her own test.

Specific Directions

SAY: Today we are going to do some work in this booklet. You have already learned how to do some parts of the work. But, you have not learned how to do other parts yet. I don't expect you to know how to do all of the work now. I will come back next month, and again and again while you are in first grade . . . each time you will have learned how to do more of the work.

Find your name on the line. Look at the little box after your name. It has an X in it. Look at the big box right next to the little box. Use your pencil and make a big X in the big box. Try to make your X come all the way to the corners of the box. [*Check to see that the children have filled in the practice box correctly.*]

Now find the first row of boxes, row A. Put your finger by the A. [*Pause.*] I am going to ask you a question. You will answer by making a big X in one of the boxes. If you don't know the answer, you may make an X in the last box, the one with a puzzled face.

EXAMPLE A

Look at the pictures in row A. Which box has a fish in it? Make an X in the box that has a fish in it. [*Pause.*] Remember, if you don't know the answer, make an X in the last box, the one with a puzzled face. [*Check to see that the children mark only one box in the row.*]

EXAMPLE B

Now find the next row of boxes, row B. Put your finger by the B. [*Pause.*] Look at the shape in the arrow. Make an X in the box that has a shape just like the shape in the arrow . . . make an X in the box that has a shape just like the shape in the arrow. [*Pause.*] Remember, if you don't know the answer, make an X in the box with a puzzled face. [*Check to see that the children mark only one box in the row.*]

Now turn to the next page and fold your booklet, like this. [*Demonstrate, folding the cover page under.*] Put your finger by row C. [*Make sure all children are on page K1, row C.*] Look at

C

the number in the arrow. Make an X in the box which has that many turtles in it . . . make an X in the box that has that many turtles in it. [*Pause.*] Remember, if you don't know the answer, mark the box with a puzzled face.

[*Note: Starting with row C, do not assist the children with the test, except to make sure they are marking only one box . . . and at least one box. You may help with the words for row I.*]

[*Repeat, "if you don't know the answer, make an X in the box with the puzzled face," frequently throughout the test.*]

D Find row D. Look at the kittens in the arrow. Make an X in the box that tells how many kittens there are . . . make an X in the box that tells how many kittens there are.

E Find row E. Look at the number sentence in the arrow Make an X on the missing number that will make the sentence true . . . make an X on the missing number that will make the sentence true.

F Find row F. Look at the number sentence in the arrow. Make an X on the missing number that will make the sentence true . . . make an X on the missing number that will make the sentence true.

Now turn to the next page and fold your booklet, like this. [*Demonstrate.*] Find row G. [*Make sure all children are on page K2, row G.*]

G I am going to read a number story about toy airplanes. I will read the story twice. Listen both times before you mark a box. David has 9 toy airplanes. His sister Nancy has 13 toy airplanes. How many more toy airplanes does Nancy have than David? [*Pause.*] David has 9 toy airplanes. His sister Nancy has 13 toy airplanes. How many more toy airplanes does Nancy have than David? [*Allow plenty of time for the children to figure out their answers to rows G and H. If necessary, remind them to use the "face" box when they don't know the answer.*]

H Row H. This number story is about cupcakes. I will read the story twice. Listen both times before you mark a box. Tom has 2 chocolate cupcakes. He also has 3 white cupcakes. How many cupcakes does Tom have altogether? [*Pause.*] Tom has 2 chocolate cupcakes. He also has 3 white cupcakes. How many cupcakes does Tom have altogether?

I Row I. Look at the cups and saucers in the arrow. Are there the same number of cups as saucers . . . the same number of cups as saucers? [*If necessary, read the answer choices to children.*]

J Row J. Look at the numbers in the arrow. What number should come next . . . what number should come next?

Now turn to the next page and fold your booklet, like this. [*Demonstrate. Make sure all children are on page K3, row K.*]

K The work on this page is quite hard. Mark the puzzled face if you do not understand how to do the work. Find row K. Look at the number sentences. [*Pause.*] One of the number sentences tells <u>how to find</u> the answer for this story about pennies. After I read the story, make an X on the number sentence that tells <u>how to find</u> the answer.

Sarah has 5 pennies. Her brother Ricky has 7 pennies. How many more pennies does Ricky have than Sarah? [*Pause.*] Sarah has 5 pennies. Her brother Ricky has 7 pennies. How many more pennies does Ricky have than Sarah?

[Note: Most children in the early test periods will no doubt be confused by rows K-N; don't be too hasty, however, about having them mark the "face" box. We may have a few children who somehow can interpret + - sentences.]

L

Row L. This number story is about hats. After I read the story twice, mark the number sentence that tells how to find the answer. Karla had 15 hats. She gave 9 hats to Steve. How many hats did Karla have left? *[Pause.]* Karla had 15 hats. She gave 9 hats to Steve. How many hats did Karla have left?

M

Row M. This number story is about links. Mark the number sentence that tells how to find the answer. Patty made a chain of links. She used 3 links first. Then she used 8 more links. How many links long is her chain? *[Pause.]* Patty made a chain of links. She used 3 links first, Then she used 8 more links. How many links long is her chain?

N

Row N. This number story is about things to drink. Mark the number sentence that tells how to find the answer. There are 11 glasses on the table. 5 have orange juice in them. The rest have milk in them. How many glasses have milk in them? *[Pause.]* There are 11 glasses on the table. 5 have orange juice in them. The rest have milk in them. How many glasses have milk in them?

Now turn to the next page and fold your booklet like this. *[Demonstrate.]* Find row O. *[Make sure all children are on page K4, row O.]*

O

We are going to count up from the number 12. When we count up one number from 12 we get 13. When we count up two numbers from 12 we get 14. What do we get when we count up five numbers from 12 . . . what do we get when we count up five numbers from 12?

P

Row P. Look at the garage and the cars. There are 15 cars altogether. We can see some cars outside the garage. The rest are inside the garage. How many cars are inside the garage? . . . There are 15 cars altogether . . . some are outside . . . the rest are inside . . . how many are inside?

Q

Row Q. I am going to tell you about some numbers . . . listen . . . 24 comes 1 number after 23 . . . 25 comes 2 numbers after 23 . . . what number comes 6 numbers after 23 . . . what number comes 6 numbers after 23?

Turn to the last page.

54

The work on this page is different. I want to see how quickly you can think of answers in your mind. You will not have time to use your fingers to figure out the answers.

I am going to play a tape--the voice on the tape will say problems, like this: [*Play the four sample problems.*] The problems go quickly. Today you probably will not know very many answers, but when I come back and we do these problems again, you will know more. Don't feel bad if you don t know the answers today.

The voice on the tape will tell you where to write your answers. Get your pencil ready. [*Start tape.*]

Script on Tape: Look at the long row of boxes. Find box A. I am going to say problems like 1 + 1. The answer for 1 + 1 is 2. So there is a 2 in box A. Find box B. What is 2 + 2? 2 + 2 is 4. You write a 4 in box B.

[*There is a 20 second pause here. Move about the room and make sure the children are working in the top row on the page.*]

Now I am going to say problems for all the rest of the boxes in this row. I will not stop. Don't try to figure out the answer with your fingers. If you can't think of the answer quickly in your mind, leave the box empty. Ready?

FORM K

Box C	3 + 1
Box D	2 + 5
Box E	1 + 6
Box F	7 + 2
Box G	2 + 6
Box H	3 + 5
Box I	4 + 8
Box J	3 + 7
Box K	5 + 9

Stop working . . . stop working. You may rest for a minute . . . then we will work on the row of circles.

[*There is a 20 second pause here.*]

Ready to listen again? Find the row of circles. Put your finger under Circle A. This time I am going to say problems like 4 take away 1. The answer for 4 take away 1 is 3. So there is a 3 in circle A. Find circle B. What is 2 take away 1? 2 take away 1 is 1. You write a 1 in circle B.

[*There is a 20 second pause here. Move about the room and make sure the children are working on the bottom row.*]

Now I am going to say problems for the rest of the circles. I will not stop. If you can't think of the answer quickly in your mind, leave the circle empty. Ready?

FORM K

Circle C	7 - 1
Circle D	8 - 4
Circle E	9 - 5
Circle F	7 - 4
Circle G	8 - 6
Circle H	4 - 3
Circle I	11 - 2
Circle J	13 - 8
Circle K	12 - 7

Stop working . . . stop working. Put your pencil down. Turn back to the page with your name on it.

[*Stop the tape.*]

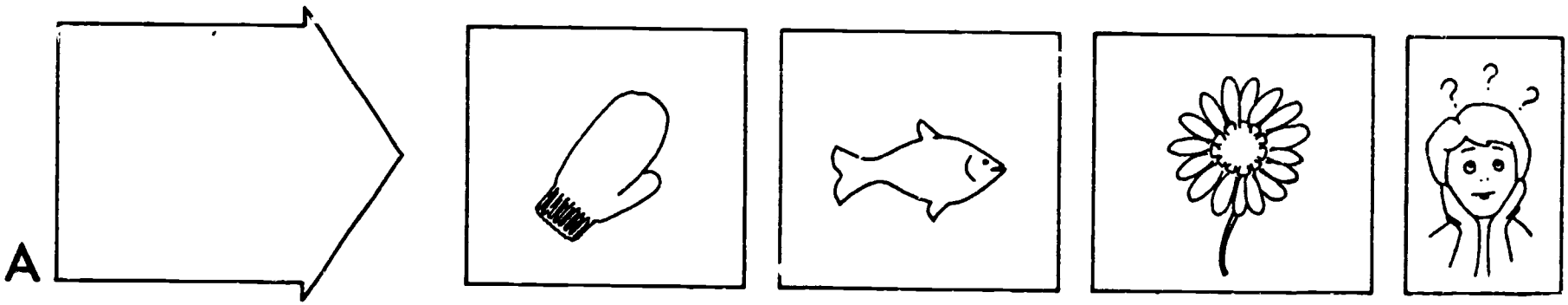
That is all the work we will do today. Remember, I will come again and you will do work like this again. Each time I come, you will be able to do more of the work.

[*Collect the booklets.*]

ID_ _ _ _ _ _ _ _ _

Date_____

Name _____ ☒



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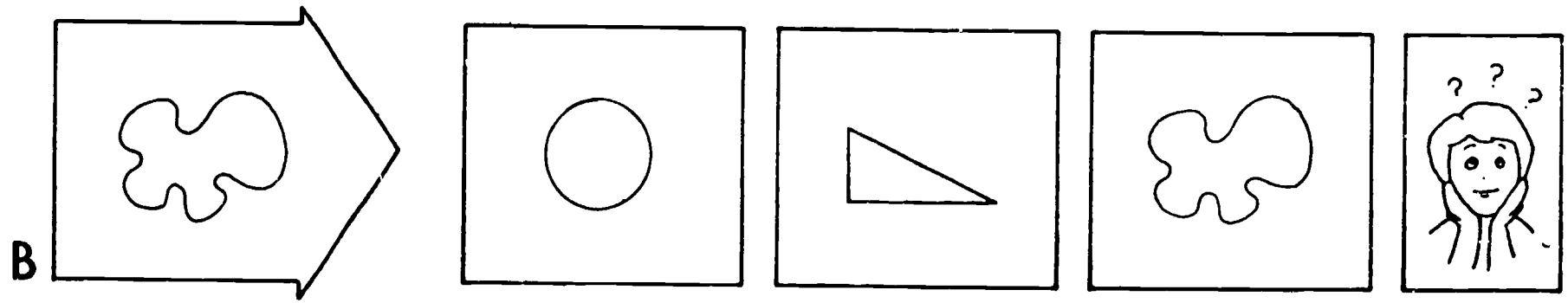

83 B

84

C

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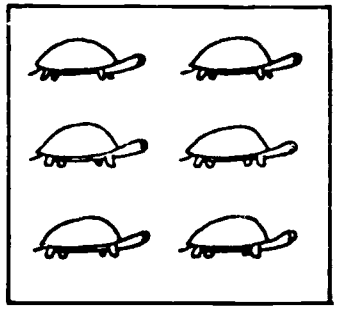

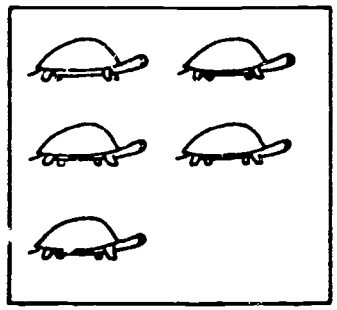

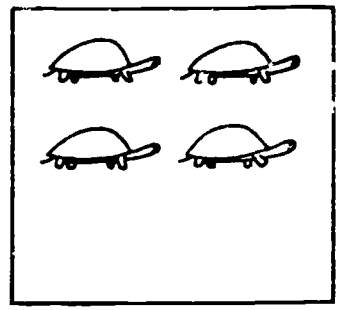

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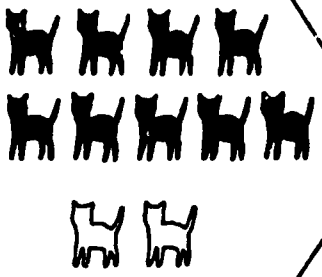


11

10

9

E

5 + 0 = □

0

50

5

F

14 - 8 = □

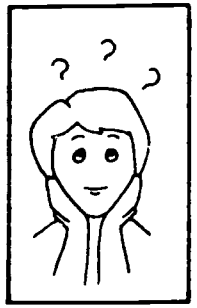
6

7

8

G

4 | 13 | 5



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3 | 5 | 1

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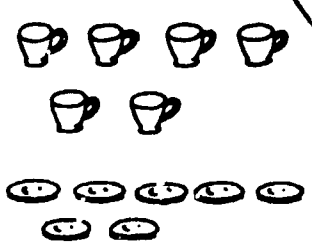


yes | no

J

10 11 12 __

9 | 14 | 13

K

	$7 5 = \square$	$7 + 5 = \square$	$7 - 5 = \square$

L

	$15 + 9 = \square$	$15 - 9 = \square$	$9 - 6 = \square$

M

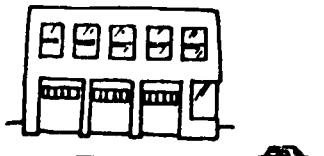
	$8 + 8 = \square$	$8 - 3 = \square$	$3 + 8 = \square$

	$11 + 5 = \square$	$11 + 6 = \square$	$11 - 5 = \square$

O

17 16 15

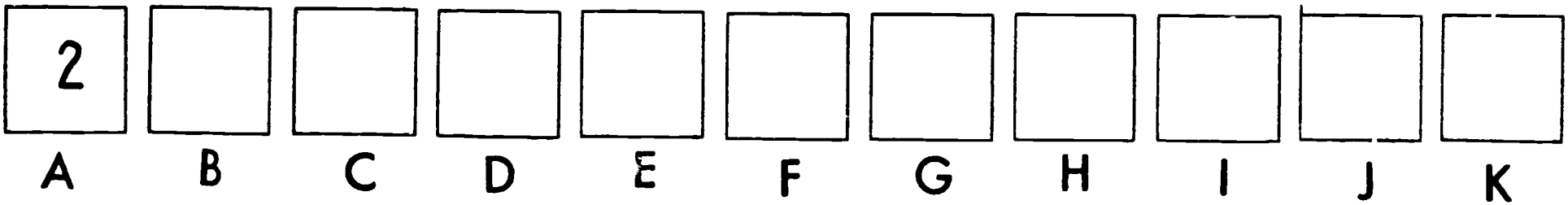
P



12 11 10

Q

28 29 30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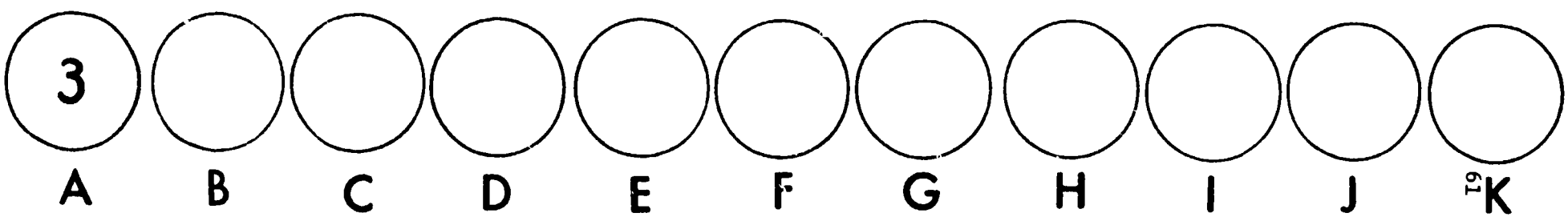
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S

Directions for Administering Achievement Monitoring Test S

Coordinated Study #1 & #2

General Directions

Reading the Test. The first part of this test is in multiple choice format and is read aloud to the children. Read the questions exactly as they are printed in the directions; do not paraphrase. Each question is read twice—or the key phrases are repeated after the original question is read. Read the questions at a somewhat slower than conversational pace. The second part of the test involves verbal problems for which the child must write, but not solve, a number sentence. Again, you will read the number story twice. The third part of the test, the basic facts speed test, will be administered via tape.

Since many children will not know how to do the majority of the test, especially at the beginning of the year, they will no doubt want to ask questions or want you to repeat items yet again. Please do not allow this--instead, ask them to answer "as best they can" or to mark the "puzzled face" to show they have "not learned this yet." Note also that reading the answers to the children is not permitted.

Since this is a group-administered test, verbal exchanges with individual children can be distracting and interfering—try to establish a policy of not talking and not allowing the children to talk in between questions.

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Preparations for Testing

The children will need two pencils with erasers. They will not need scratch paper for this test, since they will write in the "arrow" space. The children's names have been written on the tests in advance; distribute the tests, making sure each child has his/her own test.

Specific Directions

SAY: Today we are going to do some work with numbers in this booklet. You learned how to do some parts of the work last year in first grade. You will learn how to do more of the work this year in second grade. We don't expect you to know how to do all of the work today. We will come back again and again while you are in second grade . . . each time you will have learned how to do more of the work.

Find your name on the line. Look at the big box with an X in it—you will answer the questions today by making a big X like this one.

EXAMPLE A Now find row A. I am going to ask you a question. You will answer by making a big X in one of the boxes. If you haven't learned about the answer yet, make an X in the last box, the one with the puzzled face. [*Pause.*]

Which box has the tallest flag in it? Make an X on the box with the tallest flag. [*Pause.*] If you haven't learned about this yet, make an X in the last box, the one with the puzzled face. [*Check to see that the children mark only one box in the row.*]

EXAMPLE B Find row B. Look at the number in the arrow. Make an X on the box which has that many socks in it ... the box which has that many socks in it. If you haven't learned about this yet, mark the puzzled face.

Now turn to the next page and fold your booklet.

[*Note: Starting with row C, do not assist the children with the test, except to make sure they are marking only one box ... and at least one box.*]

C Row C. Look at the sticks in the arrow. Make an X on the box that tells how many sticks there are ... the box that tells how many sticks there are. [*Pause.*] Remember, if you haven't learned about this yet, mark the puzzled face.

D Row D. Make an X on the box that has 24 cubes in it ... 24 cubes in it.

E Row E. Look at the number sentence in the arrow. Make an X on the number that will make the sentence true ... make an X on the number that will make the sentence true.

F Row F. Look at the number sentence in the arrow. Make an X on the number that will make the sentence true ... make an X on the number that will make the sentence true.

G Row G. I am going to read a number story about toy airplanes. I will read the story twice. Listen both times before you mark a box. David has 9 toy airplanes. His sister Nancy has 13 toy airplanes. How many more toy airplanes does Nancy have than David? [*Repeat. Allow time for the children to figure out their answers to rows G and H.*]

H Row H. This number story is about bottle caps. For this story you may write on the paper if you want to. Tom has 24 old bottle caps. He also has 57 new bottle caps. How many bottle caps does Tom have altogether? [*Repeat. If necessary, remind the children to "make an X" on their answer. Also, use the "puzzled face" reminder as necessary.*]

I Row I. Which box shows the numbers in order from smallest to largest ... in order from smallest to largest?

J Row J. Look at the little squares in the arrow. Make an X on the box that tells how many squares there are...how many squares there are.

K Row K. Look at the number sentences. One of the number sentences tells how to find the answer for this story about hats. After I read the story, make an X on the number sentence that tells how to find the answer. Karla had 15 hats. She gave 9 hats to Steve. How many hats did Karla have left? [*Repeat.*]

L Row L. This number story is about stickers. Make an X on the number sentence that tells how to find the answer. Sarah has 28 stickers. Her brother Ricky has 34 stickers. How many more stickers does Ricky have than Sarah? [*Repeat.*]

M Row M. This number story is about things to drink. There are 11 glasses on the table. 5 have orange juice in them. The rest have milk in them. How many glasses have milk in them? [*Repeat.*]

N Row N. This number story is about children swimming. There were 46 children swimming in the pool. 27 more children jumped into the pool. How many children were in the pool then? [*Repeat.*]

Turn to the next page.

O Row O. This number story is about shells. 17 shells are in a box. Some shells are little. 8 are big. How many little shells are in the box? [*Repeat.*]

P Row P. This number story is about soccer. For this story you may write on the paper if you want to. There were some soccer players on the field. 23 more players came. Now there are 35 players on the field. How many players were on the field at first? [*Repeat. Use "puzzled face" and "make an X" reminders as necessary.*]

Q Look at the problem in the arrow. What number is the answer ... what number is the answer? [*Mention "puzzled face."*]

R Look at the problem in the arrow. What number is the answer ... what number is the answer? [*Mention "puzzled face."*]

S Row S. We are going to count up from the number 12. When we count up one number from 12 we get 13. When we count up two numbers from 12 we get 14. What do we get when we count up five numbers from 12 ... what do we get when we count up five numbers from 12?

T Row T. Look at the garage and the cars. There are 15 cars altogether. We can see some cars outside the garage. The rest are inside the garage. How many cars are inside the garage? There are 15 cars altogether ... some are outside ... the rest are inside ... how many are inside?

Turn to the next page.

U Row U. I am going to tell you about some numbers ... listen ... 24 comes 1 number after 23 ... 25 comes 2 numbers after 23 ... what number comes 6 numbers after 23 ... what number comes 6 numbers after 23?

Now we will do some different work. I will read a number story to you. Then I want you to write a number sentence for the story. You don't need to solve the sentence. Just write the sentence the best you can without solving it. Write it on the line.

STORY A Judy has 4 chocolate cupcakes. She also has 7 white cupcakes. How many cupcakes does Judy have altogether? [*Repeat.*]

STORY B Steve had 65 pennies. He gave 36 of them to Laura. How many pennies did Steve have left? [*Repeat.*]

STORY C There are 86 marbles in a jar. 54 are big and the rest are little. How many little marbles are in the jar? [*Repeat.*]

STORY D Adam has 7 puzzles. How many more puzzles does he have to put with them so he has 12 puzzles altogether? [*Repeat.*]

Turn to the last page.

66

The work on this page is different. I want to see how quickly you can think of the answers for addition and subtraction problems.

I am going to play a tape—the voice on the tape will say problems, like this: [*Play the four sample problems 2 + 8, 5 + 6, 7 + 4, 8 + 3.*] The problems will go very quickly, even faster than when you were in first grade. Today you probably will not know very many answers, but when I come back and we do these problems again, you will know more. Don't feel bad if you don't know the answers today.

We will start with the row of boxes at the top of the page—the ones with capital letters A, B, C .... The voice on the tape will tell you where to write your answers. Do your best to keep up with the voice. Get your pencil ready. [*Start tape.*]

Script on Tape: Look at the row of boxes at the top of the page. Find box A. I am going to say problems like 5 + 4. The answer for 5 + 4 is 9. So there is a 9 in box A. Find Box B. What is 7 + 1? 7 + 1 is 8. You write an 8 in box B.

[*10 second pause; make sure the children are working on the top row.*]

Now I am going to say problems for all the rest of the boxes in the top row. I will not stop, so write your answers quickly. If you can't think of an answer, just leave the box empty. Ready?

Form S

Box C 3 + 1

Box D 2 + 5

Box E 1 + 6

Box F 7 + 2

Box G 2 + 6

Box H 3 + 5

Box I 4 + 8

Box J 3 + 7

Box K 5 + 9

Box L 6 + 8

Box M 8 + 7

Box N 4 + 9

Stop working. You may rest for a moment...then we will work on the bottom row.

[*10 second pause*]

Ready to listen again? Look at the bottom row of boxes. Find Box A. This time I am going to say problems like 9 - 6. The answer for 9 - 6 is 3. So there is a 3 in box A. Find box B. What is 4 - 2? 4 - 2 is 2. You write a 2 in box B.

[*10 second pause--make sure the children are in the bottom row.*]

Now I am going to say problems for the rest of the boxes. I will not stop, so write your answers quickly. If you can't think of an answer, leave the box empty. Ready?

Form S

Box C 7 - 1

Box D 8 - 4

Box E 9 - 5

Box F 7 - 4

Box G 8 - 6

Box H 4 - 3

Box I 11 - 2

Box J 13 - 8

Box K 12 - 7

Box L 15 - 9

Box M 10 - 2

Box N 16 - 7

Stop working. Put your pencil down.

[*Stop the tape.*]

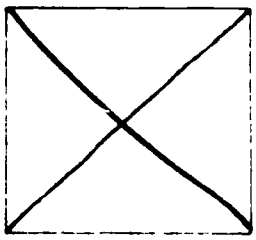
That is all the work we will do today. Remember, we will come again and you will do work like this again. Each time I come, you will be able to do more of the work.

[*Collect the booklets.*]

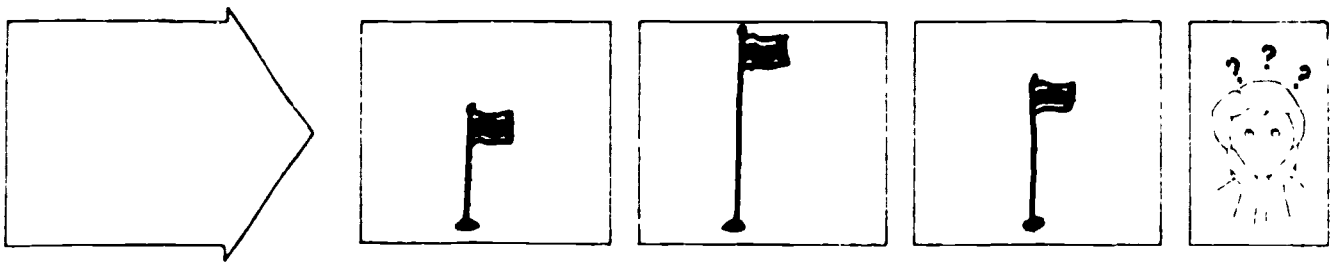
ID 68 _ _ _ _ _ _ _ _

S

Name _____



A



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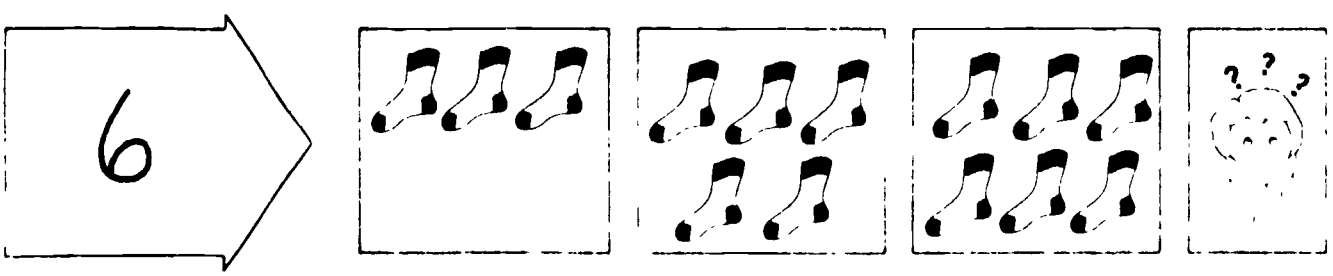

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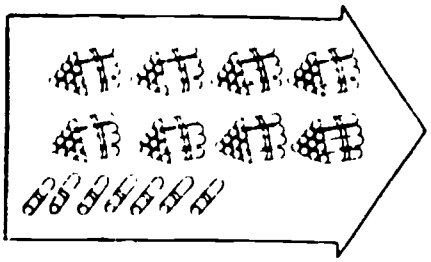

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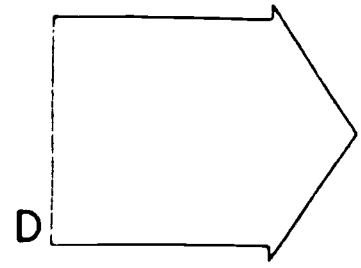

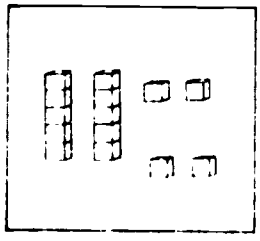	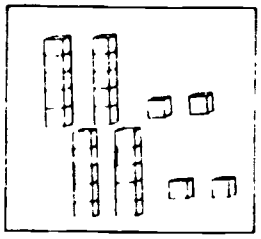	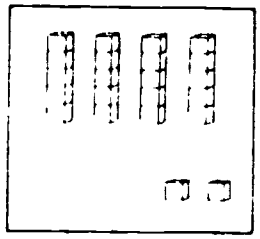	

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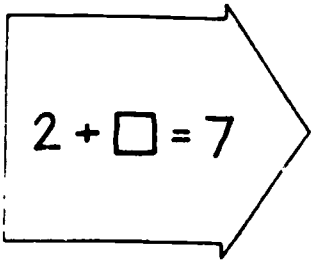
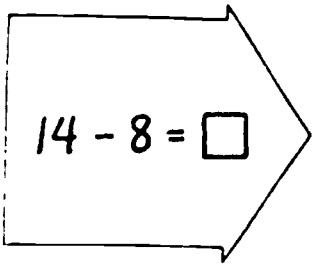


5	9	7	

F



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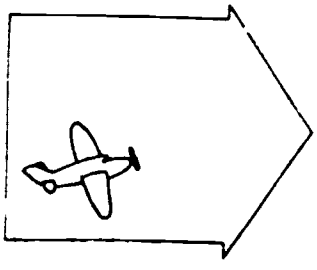

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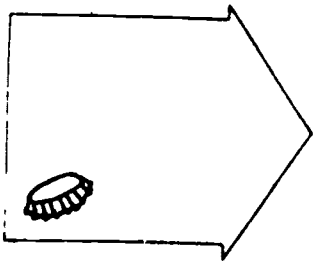
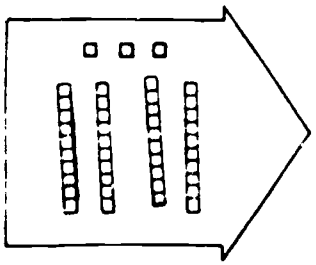
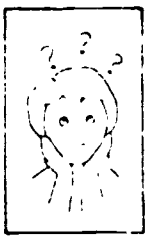
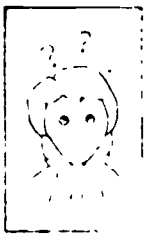
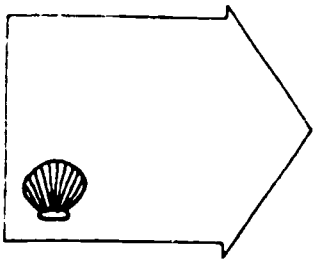
H



33	73	81	

I		92 98 89	37 57 63	28 82 36	
J		3 tens + 13 ones	3 tens + 4 ones	4 tens + 13 ones	
K		15 + 9 = ☐	15 − 9 = ☐	9 − 6 = ☐	
L		28 + 34 = ☐	34 + 6 = ☐	34 − 28 = ☐	
M		11 + 5 = ☐	11 + 6 = ☐	11 − 5 = ☐	
N		46 − 27 = ☐	46 + 27 = ☐	61 + 27 = ☐	

O 

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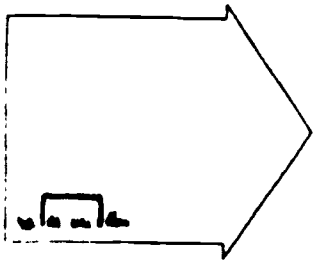
P 

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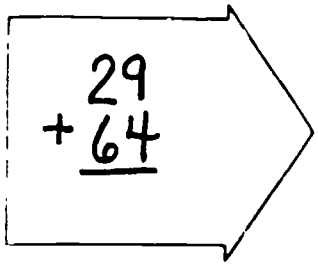
Q 

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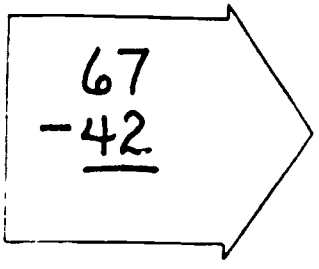
R 

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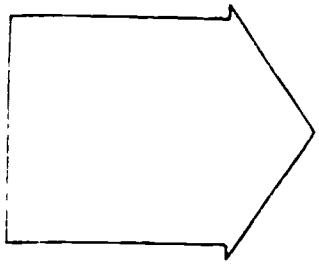
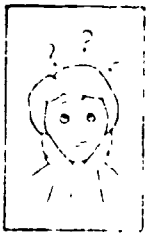
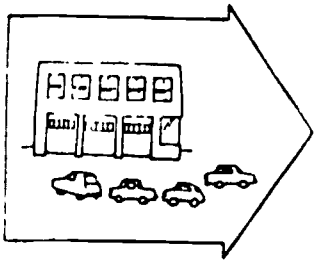
S 

17	16	15	

T 

12	11	10	

U

28

29

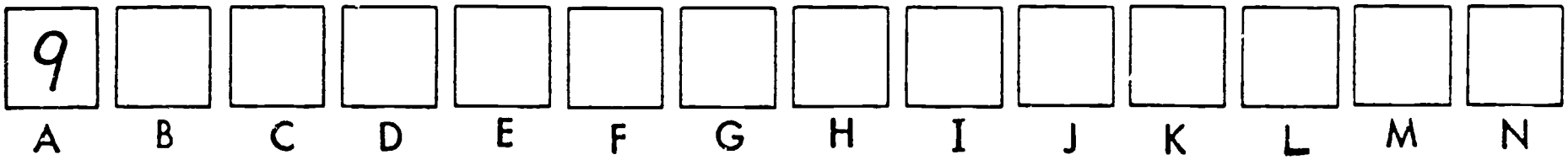
30

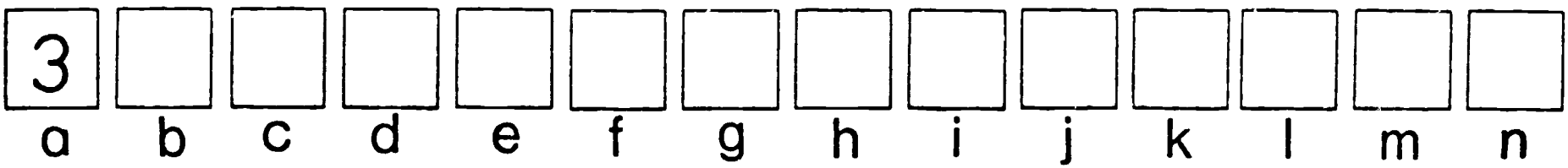
A 

B 

C 

D 


9
A B C D E F G H I J K L M N


3
a b c d e f g h i j k l m n

V

Directions for Administering Achievement Monitoring Test V

Coordinated Study #1 & #2

General Directions

Reading the Test. The first part of this test is in multiple choice format and is read aloud to the children. Read the questions exactly as they are printed in the directions; do not paraphrase. Each question is read twice--or the key phrases are repeated after the original question is read. Read the questions at a conversational pace. The second part of the test involves verbal problems for which the child must write, but not solve, a number sentence. Again, you will read the number story twice. The third part of the test is timed and assesses the child's speed and accuracy using the addition and subtraction algorithms. The fourth segment, the basic facts speed test, is administered via tape.

Since many children will not know how to do the majority of the test, especially at the beginning of the year, they will no doubt want to ask questions or want you to repeat items yet again. Please do not allow this--instead, ask them to answer "as best they can" or to mark the "puzzled face" to show they have "not learned this yet." Note also that reading the answers to the children is not permitted.

Since this is a group-administered test, verbal exchanges with individual children can be distracting and interfering--try to establish a policy of not talking and not allowing the children to talk in between questions.

Should the above directions seem unnecessarily stringent, please realize that we are attempting to measure change over time and that we have very few questions on which to base this measurement. The children will take the other forms of this same test at 6 week intervals and then they will repeat the three forms; hopefully each time they will be able to answer the questions more successfully.

Make sure the children mark only one box and that they mark at least one box. Encourage them to use the "puzzled face" by reminding them that this response means "I haven't learned this (how to do this) yet."

Pacing the Test. Try to keep the test moving. Expecially for the number story and algorithm problems it may take a "long" time for the children to figure out an answer. As a rule of thumb, allow the group to work on each question until only one or two children are still working. At that point, if necessary, suggest that anyone still working mark the "puzzled face" box. Then just go on to the next question without waiting longer. The second part of the test, sentence writing, may go slowly. Remind the children

not to solve the problem. The third part of the test is timed and must be administered accordingly.

The last section, the taped basic facts, is a speed test. Once the tape is started, it will not be stopped.

Estimated Administration Times

Part 1 10 min.
Part 2 5 min.
Part 3 15 min.
Part 4 5 min.

Preparations for Testing

The children will need two pencils with erasers. They will not need scratch paper for this test, since they will write in the "arrow" space. The children's names have been written on the tests in advance; distribute the tests, making sure each child has his/her own test.

Specific Directions

SAY: Today we are going to do some work with numbers in this booklet. You learned how to do some parts of the work last year in first grade. You will learn how to do more of the work this year in second grade. We don't expect you to know how to do all of the work today. We will come back again and again while you are in second grade . . . each time you will have learned how to do more of the work.

Find your name on the line. Look at the big box with an X in it--you will answer the questions today by making a big X like this one.

EXAMPLE A Now find row A. I am going to ask you a question. You will answer by making a big X in one of the boxes. If you haven't learned about the answer yet, make an X in the last box, the one with the puzzled face. [*Pause.*]

Which box has a triangle in it? Make an X on the box with a triangle in it. [*Pause*] If you haven't learned this yet, make an X on the box with the puzzled face. [*Check to see that the children mark only one box in the row.*]

EXAMPLE B Find Row B. Look at the numbers in the arrow. What number comes next? Make an X on the number that comes next.

Now turn to the next page and fold your booklet.

[*Note: Starting with row C, do not assist the children with the test, except to make sure they are marking only one box ... and at least one box.*]

C Row C. Look at the sticks in the arrow. Make an X on the box that tells how many sticks there are ... the box that tells how many sticks there are. [*Pause.*] Remember, if you haven't learned about this yet, mark the puzzled face.

D Row D. Make an X on the box that has 24 cubes in it ... 24 cubes in it.

E Row E. I am going to read a number story about toy airplanes. I will read the story twice. Listen both times before you mark a box. David has 9 toy airplanes. His sister Nancy has 13 toy airplanes. How many more toy airplanes does Nancy have than David? [*Repeat. Allow time for the children to figure out their answers to rows E-H.*]

F Row F. This number story is about bottle caps. For this story you may write on the paper if you want to. Tom has 24 old bottle caps. He also has 57 new bottle caps. How many bottle caps does Tom have altogether? [*Repeat. If necessary, remind the children to "make an X" on their answer. Also, use the "puzzled face" reminder as necessary.*]

G Row G. This number story is about shells. 17 shells are in a box. Some shells are little. 8 are big. How many little shells are in the box? [*Repeat.*]

H Row H. This number story is about soccer. For this story you may write on the paper if you want to. There were some soccer players on the field. 23 more players came. Now there are 35 players on the field. How many players were on the field at first? [*Repeat. Use "puzzled face" and "make an X" reminders as necessary.*]

Turn to the next page.

I Row I. Which box shows the numbers in order from smallest to largest ... in order from smallest to largest?

J Row J. Look at the little squares in the arrow. Make an X on the box that tells how many squares there are...how many squares there are.

K Row K. Look at the number sentences. One of the number sentences tells how to find the answer for this story about hats. After I read the story, make an X on the number sentence that tells how to find the answer. Karla had 15 hats. She gave 9 hats to Steve. How many hats did Karla have left? [*Repeat.*]

L Row L. This number story is about stickers. Make an X on the number sentence that tells how to find the answer. Sarah has 28 stickers. Her brother Ricky has 34 stickers. How many more stickers does Ricky have than Sarah? [*Repeat.*]

M Row M. This number story is about things to drink. There are 11 glasses on the table. 5 have orange juice in them. The rest have milk in them. How many glasses have milk in them? [*Repeat.*]

N Row N. This number story is about children swimming. There were 46 children swimming in the pool. 27 more children jumped into the pool. How many children were in the pool then? [*Repeat.*]

Turn to the next page.

O Row C. Look at the problem in the arrow. What number is the answer ... what number is the answer? [*Mention "write on paper" reminder*]

P Row P. Look at the problem in the arrow. What number is the answer ... what number is the answer?

Now we will do some different work. I will read a number story to you. Then I want you to write a number sentence for the story. You don't need to solve the sentence. Just write the sentence the best you can without solving it. Write it on the line.

STORY A Judy has 4 chocolate cupcakes. She also has 7 white cupcakes. How many cupcakes does Judy have altogether? [*Repeat.*]

STORY B Steve had 65 pennies. He gave 36 of them to Laura. How many pennies did Steve have left? [*Repeat.*]

STORY C There are 86 marbles in a jar. 54 are big and the rest are little. How many little marbles are in the jar? [*Repeat*]

STORY D Adam has 7 puzzles. How many more puzzles does he have to put with them so he has 12 puzzles altogether? [*Repeat.*]

[*Give the children a short stand up-stretch-touch toes--and so on--"break" here.*]

Turn to the next page, the one that says "ADD" at the top.

Be sure you have the page that says "ADD" on it All the problems on this page are addition problems. Each problem has a letter by it ... A, B, C, D... all the way to V, W and X. When I say "GO", start with problem A, then do B, then C, and so on until I say "STOP!" If you can't do a problem, go on to the next one. Do as many problems as you can before I say "STOP!" Ready? GO! (Allow 6 minutes) STOP! You worked very hard on these problems. You will be learning how to do them faster. (Reassure the children as you see fit.) Now turn to the page that says "SUBTRACT."

Be sure you have the page that says "SUBTRACT." All the problems on this page are subtraction. When I say "GO," start with problem A, then do B, then C... do as many as you can before I say "STOP!" Ready? GO! (Allow 6 minutes.) I could tell you tried your best on these problems. You will be learning how to do them faster.

Now turn to the last page.

78 The work on this page is different. I want to see how quickly you can think of the answers for addition and subtraction problems.

I am going to play a tape--the voice on the tape will say problems, like this: [*Play the four sample problems 2 + 8, 5 + 6, 7 + 4, 8 + 3.*] The problems will go very quickly, even faster than when you were in first grade. Today you probably will not know very many answers, but when I come back and we do these problems again, you will know more. Don't feel bad if you don't know the answers today.

We will start with the row of boxes at the top of the page--the ones with capital letters A, B, C .... The voice on the tape will tell you where to write your answers. Do your best to keep up with the voice. Get your pencil ready. [*Start tape.*]

Script on Tape: Look at the row of boxes at the top of the page. Find box A. I am going to say problems like 5 + 4. The answer for 5 + 4 is 9. So there is a 9 in box A. Find Box B. What is 7 + 1? 7 + 1 is 8. You write an 8 in box B.

[*10 second pause; make sure the children are working on the top row.*]

Now I am going to say problems for all the rest of the boxes in the top row. I will not stop, so write your answers quickly. If you can't think of an answer, just leave the box empty. Ready?

Form V

Box C 3 + 1

Box D 2 + 5

Box E 1 + 5

Box F 7 + 2

Box G 2 + 6

Box H 3 + 5

Box I 4 + 8

Box J 3 + 7

Box K 5 + 9

Box L 6 + 8

Box M 8 + 7

Box N 4 + 9

Stop working. You may rest for a moment...then we will work on the bottom 79 row.

[*10 second pause*]

Ready to listen again? Look at the bottom row of boxes. Find Box A. This time I am going to say problems like 9 - 6. The answer for 9 - 6 is 3. So there is a 3 in box A. Find box B. What is 4 - 2? 4 - 2 is 2. You write a 2 in box B.

[*10 second pause--make sure the children are in the bottom row.*]

Now I am going to say problems for the rest of the boxes. I will not stop, so write your answers quickly. If you can't think of an answer, leave the box empty. Ready?

Form V

Box C 7 - 1

Box D 8 - 4

Box E 9 - 5

Box F 7 - 4

Box G 8 - 6

Box H 4 - 3

Box I 11 - 2

Box J 13 - 8

Box K 12 - 7

Box L 15 - 9

Box M 10 - 2

Box N 16 - 7

Stop working. Put your pencil down.

[*Stop the tape.*]

That is all the work we will do today. Remember, we will come again and you will do work like this again. Each time I come, you will be able to do more of the work.

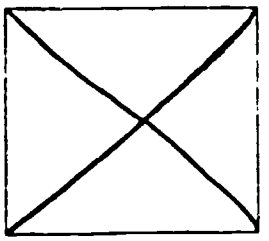
[*Collect the booklets.*]

V

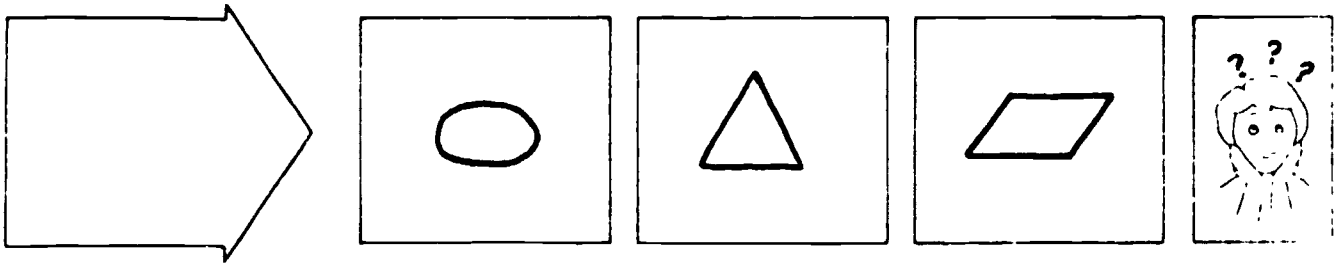
80

ID_ _ _ _ _ _ _ _

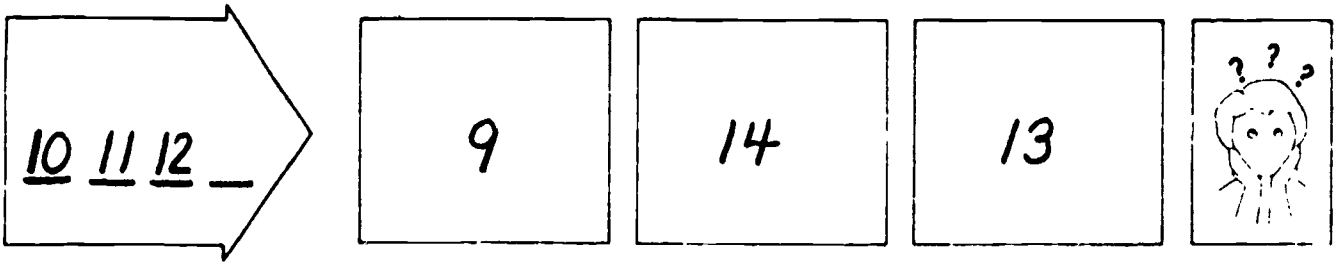
Name _____



A



B



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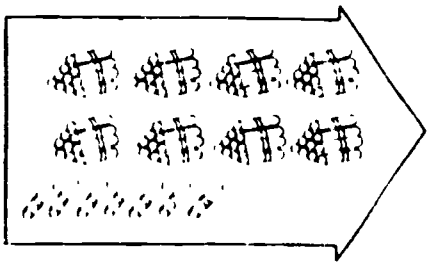
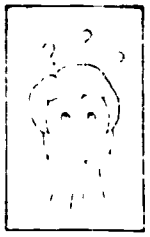


87	97	15	

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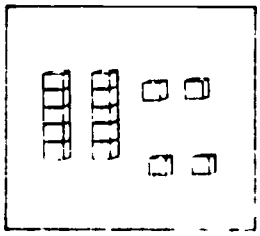
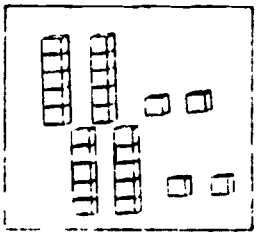
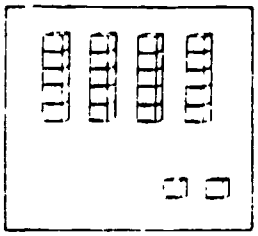
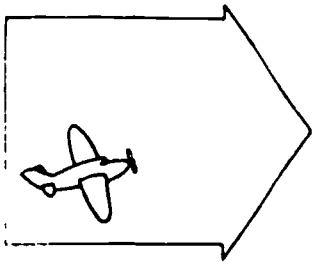
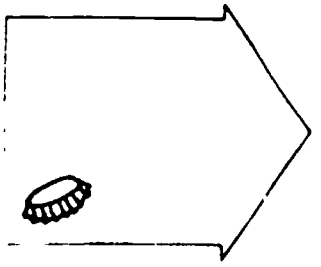
			

E



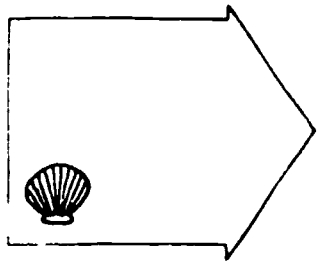
4	13	5	

F



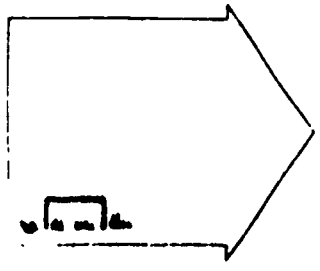
33	73	81	

G



25	17	9	

H



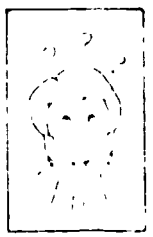
12	23	58	

I

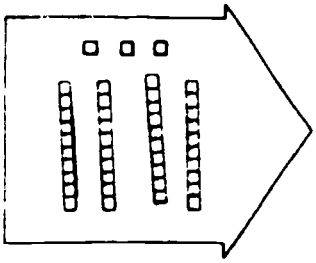
92 98 89

37 57 63

28 82 36



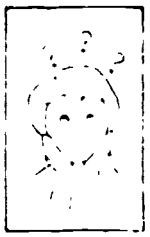
J



3 tens + 13 ones

3 tens + 4 ones

4 tens + 13 ones

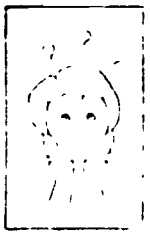


K

$15 + 9 = \square$

$15 - 9 = \square$

$9 - 6 = \square$

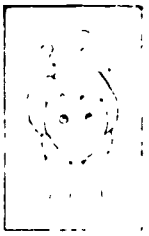


L

$28 + 34 = \square$

$34 + 6 = \square$

$34 - 28 = \square$



M

$11 + 5 = \square$

$11 + 6 = \square$

$11 - 5 = \square$

N

$46 - 27 = \square$

$46 + 27 = \square$

$61 + 27 = \square$

O

$$\begin{array}{r} 16 \\ +44 \\ \hline \end{array}$$

60	50	61	

P

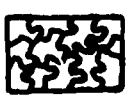
$$\begin{array}{r} 85 \\ -59 \\ \hline \end{array}$$

34	44	26	

A  _____

B  _____

C  _____

D  _____

Add

A. 53 + 34

B. 30 + 21

C. 27 + 62

D. 503 + 293

E. 265 + 314

F. 332 + 246

G. 7 + 56

H. 68 + 8

I. 79 + 7

J. 29 + 64

K. 45 + 28

L. 77 + 95

M. 426 + 458

N. 239 + 653

O. 115 + 875

P. 174 + 642

Q. 583 + 241

R. 186 + 570

S. 263 + 459

T. 359 + 265

U. 767 + 434

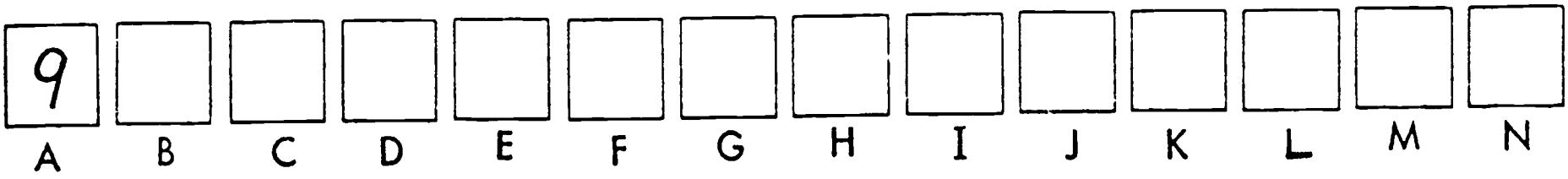
V. 19 64 + 58

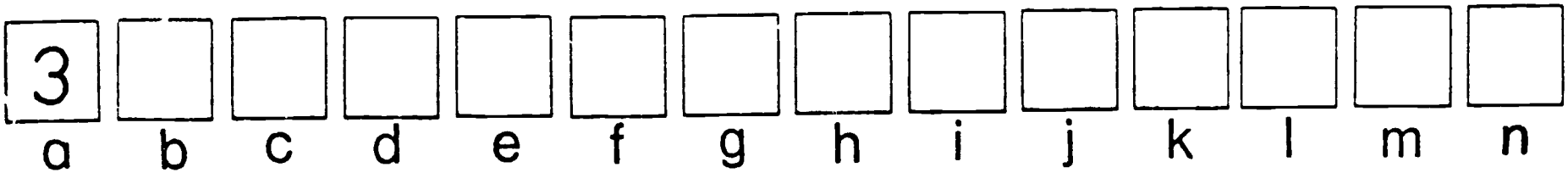
W. 67 25 + 22

X. 58 98 + 85

Subtract

A. 67 − 42	G. 32 − 5	M. 256 − 138	S. 623 − 334
B. 56 − 25	H. 74 − 8	N. 388 − 269	T. 872 − 586
C. 88 − 76	I. 61 − 5	O. 913 − 408	U. 436 − 337
D. 698 − 457	J. 72 − 28	P. 846 − 393	V. 730 − 438
E. 482 − 231	K. 83 − 67	Q. 929 − 743	W. 504 − 227
F. 985 − 265	L. 85 − 59	R. 726 − 186	X. 600 − 481


9
A B C D E F G H I J K L M N


3
a b c d e f g h i j k l m n

Appendix B

GUIDELINES FOR ACHIEVEMENT MONITORING

Guidelines

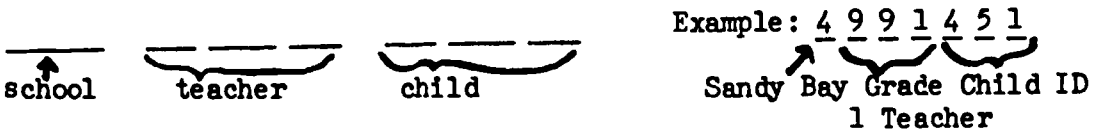
Achievement Monitoring

Test Assignment

Grade 1	Test K
Grade 2	Test S
Grade 3	Test V

ID Information

Use the same ID's as for the interviews:



Bias

The tests were checked for bias. There are US pennies pictured in both. If the administrators feel other terms are biased, have them changed but please keep a record of this and return it to me. The test administrators should realize that the February testing is baseline and therefore should encourage the children to feel that they can mark the "puzzled face" if "they haven't learned about the question" yet.

Linda Harvey (01)

Sandy Bay Infant School

Testing and Observation Schedule (991,992)

Interviews:

February 27-29
April 9-11
May 26-28

Achievement Monitoring:

February 29
April 11
May 28

Observations:

March 3 - May 23
twice a week in each class during Maths period

Teacher Logs:

Filled out last observational day each week March 3 - May 23.

Wendy Craw (02)

Waimea Heights Primary School

Testing and Observation Schedule (993, 995)

Interviews:

February 27-29
April 9-11
May 26-28

Achievement Monitoring:

February 29
April 11
May 28

Observations:

March 3 - May 23
twice a week in each class during Maths period

Teacher Logs

Filled out last observational day each week March 3 - May 23

Denise Fisher (03)

Waimea Heights Primary School

Testing and Observation Schedule (994)

Interviews:

February 27-29
April 9-11
May 26-28

Achievement Monitoring:

February 29
April 11
May 28

Observations:

March 3 - May 23
Three times a week during maths period

Teacher Logs:

Filled out last observational day each week March 3 - May 23

Appendix C

COGNITIVE LEVEL BY ADMINISTRATION TABLES

Appendix C-1

Frequency and Percent Correct for Composite Objectives by

Cognitive Level and Administration Time for Grade 1, Form K

Objectives	Number of Items	Feb. N=3 f/%	Feb. N=3 t	April N=3 f/%	April N=3 t	May N=3 f/%	May N=3 t
Cognitive Level 1							
Prerequisite Instructional Objectives							
Numerousness 0-20	2	5/83	6	4/67	6	5/83	6
Ordering 0-20	2	5/83	6	5/83	6	6/100	6
Instructional Objectives for the S Topics							
Open Sentences	2	3/50	6	1/17	6	3/50	6
Sentence-writing 0-20	4	3/25	12	0/0	12	1/8	12
Noninstructional Objectives							
Problem-solving 0-20	2	3/50	6	4/67	6	5/83	6
Counting	3	1/11	9	0/0	9	1/11	9
Addition Facts Recall--Speeded Test	9	1/4	27	6/22	27	17/63	27
Subtraction Facts Recall--Speeded Test	9	5/19	27	8/30	27	11/41	27

continued

Appendix C-1 (continued)

Objectives	Number of Items	Feb. N=3 f/%	Feb. N=3 t	April N=3 f/%	April N=3 t	May N=3 f/%	May N=3 t
		Cognitive Level 2					
Prerequisite Instructional Objectives							
Numerousness 0-20	2	6/100	6	5/83	6	6/100	6
Ordering 0-20	2	6/100	6	5/83	6	4/67	6
Instructional Objectives for the S Topics							
Open Sentences	2	1/17	6	3/50	6	3/50	6
Sentence-writing 0-20	4	3/25	12	3/25	12	3/25	12
Noninstructional Objectives							
Problem-solving 0-20	2	5/83	6	3/50	6	5/83	6
Counting	3	3/33	9	7/78	9	6/67	9
Addition Facts Recall—Speeded Test	9	19/70	27	22/81	27	24/89	27
Subtraction Facts Recall--Speeded Test	9	12/44	27	18/67	27	19/70	27

continued

Appendix C-1 (continued)

Objectives	Number of Items	Feb. N=1 f/%	Feb. N=1 t	April N=1 f/%	April N=1 t	May N=1 f/%	May N=1 t
		Cognitive Level 3					
Prerequisite Instructional Objectives							
Numerousness 0-20	2	1/50	2	1/50	2	2/100	2
Ordering 0-20	2	2/100	2	2/100	2	2/100	2
Instructional Objectives for the S Topics							
Open Sentences	2	0/2	0	1/50	2	1/50	2
Sentence-writing 0-20	4	0/0	4	0/0	4	2/50	4
Noninstructional Objectives							
Problem-solving 0-20	2	1/50	2	1/50	2	2/100	2
Counting	3	0/0	3	0/0	3	2/67	3
Addition Facts Recall--Speeded Test	9	1/11	9	3/33	9	7/78	9
Subtraction Facts Recall--Speeded Test	9	1/11	9	2/22	9	5/56	9

Appendix C-2

Frequency and Percent Correct for Composite Objectives by

Cognitive Level and Administration Time for Grade 2, Form S

Objectives	Number of Items	Feb. N=2 f/%	Feb. N=2 t	April N=2 f/%	April N=2 t	May N=2 f/%	May N=2 t
Cognitive Level 1							
Prerequisite Instructional Objectives							
Numerousness 0-99	1[a]	1/50	2	1/50	2	2/100	2
Ordering, Place Value 0-99	2	1/25	4	0/0	4	2/50	4
Instructional Objectives for the S and A Topics							
Open Sentences	2	0/0	4	0/0	4	4/100	4
Sentence-writing 0-20, 0-99 (multiple choice)	4	0/0	8	0/0	8	1/13	8
Sentence-writing 0-20, 0-99 (free response)	4	0/0	8	4/50	8	5/63	8
Algorithms	2	0/0	4	0/0	4	1/25	4
Noninstructional Objectives							
Problem-Solving 0-20, 0-99	4	4/50	8	4/50	8	3/38	8
Counting	3	2/33	6	1/17	6	3/50	6
Addition Facts Recall--Speeded Test	12	4/17	24	4/17	24	9/38	24
Subtraction Facts Recall--Speeded Test	12	2/8	24	2/8	24	12/50	24

continued

Appendix C-2 (continued)

Objectives	Number of Items	Feb. N=5 f/%	Feb. N=5 t	April N=5 f/%	April N=5 t	May N=4 f/%	May N=4 t
Cognitive Level 2							
Prerequisite Instructional Objectives							
Numerousness 0-99	1[a]	2/40	5	4/80	5	2/50	4
Ordering, Place Value 0-99	2	0/0	10	0/0	10	0/0	8
Instructional Objectives for the S and A Topics							
Open Sentences	2	2/20	10	5/50	10	6/75	8
Sentence-writing 0-20, 0-99 (multiple choice)	4	5/25	20	4/20	20	2/13	16
Sentence-writing 0-20, 0-99 (free response)	4	6/30	20	9/45	20	10/63	16
Algorithms	2	1/10	10	2/20	10	1/13	8
Noninstructional Objectives							
Problem-Solving 0-20, 0-99	4	2/10	20	6/30	20	3/19	16
Counting	3	3/20	15	4/27	15	7/58	12
Addition Facts Recall—Speeded Test	12	14/23	60	20/33	60	24/50	48
Subtraction Facts Recall--Speeded Test	12	11/18	60	15/25	60	24/50	48

continued

Appendix C-2 (continued)

Objectives	Number of Items	Feb. N=2 f/%	Feb. N=2 t	April N=2 f/%	April N=2 t	May N=2 f/%	May N=2 t
Cognitive Level 3							
Prerequisite Instructional Objectives							
Numerousness 0-99	1[a]	2/100	2	1/50	2	2/100	2
Ordering, Place Value 0-99	2	0/0	4	0/0	4	1/25	4
Instructional Objectives for the S and A Topics							
Open Sentences	2	1/25	4	2/50	4	4/100	4
Sentence-writing 0-20, 0-99 (multiple choice)	4	1/13	8	1/13	8	2/25	8
Sentence-writing 0-20, 0-99 (free response)	4	4/50	8	6/75	8	4/50	8
Algorithms	2	1/25	4	1/25	4	2/50	4
Noninstructional Objectives							
Problem-Solving 0-20, 0-99	4	2/25	8	4/50	8	2/25	8
Counting	3	3/50	6	4/67	6	5/83	6
Addition Facts Recall--Speeded Test	12	13/54	24	14/58	24	16/67	24
Subtraction Facts Recall--Speeded Test	12	12/50	24	15/63	24	16/67	24

[a]Two items were administered for the numerousness objective; students had difficulty reading one of the items due to poor quality of the test duplication so data for this item were discarded.

Appendix C-3

Frequency and Percent Correct for Composite Objectives by

Cognitive Level and Administration Time for Grade 3, Forms S and V

Objectives	Number of Items	Feb. N=4 f/%	t	April N=4 f/%	t	May N=4 f/%	t
Cognitive Level 2							
Prerequisite Instructional Objectives							
Numerousness 0-99	2	4/50	8	5/63	8	6/75	8
Ordering, Place Value 0-99	2	1/13	8	4/50	8	3/38	8
Instructional Objectives for the S and A Topics							
Sentence-writing 0-20, 0-99 (multiple choice)	4	8/50	16	7/44	16	6/38	16
Sentence-writing 0-20, 0-99 (free response)	4	4/25	16	11/69	16	11/69	16
Noninstructional Objectives							
Problem-Solving 0-20, 0-99	4	7/44	16	13/81	16	14/81	16
Addition Algorithms--Timed Test[a]	24	30/31	96	--	--	--	--
Subtraction Algorithms--Timed Test[a]	24	12/13	96	--	--	--	--
Addition Facts Recall--Speeded Test	12	14/29	48	25/52	48	26/54	48
Subtraction Facts Recall--Speeded Test	12	13/27	48	28/58	48	20/42	48

continued

Appendix C-3 (continued)

Objectives	Number of Items	Feb. N=7 f/%	Feb. N=7 t	April N=6 f/%	April N=6 t	May N=7 f/%	May N=7 t
Cognitive Level 3							
Prerequisite Instructional Objectives							
Numerousness 0-99	2	9/64	14	9/75	12	11/79	14
Ordering, Place Value 0-99	2	6/43	14	7/58	12	7/50	14
Instructional Objectives for the S and A Topics							
Sentence-writing 0-20, 0-99 (multiple choice)	4	10/36	28	16/67	24	16/57	28
Sentence-writing 0-20, 0-99 (free response)	4	14/50	28	16/67	24	19/68	28
Noninstructional Objectives							
Problem-Solving 0-20, 0-99	4	20/71	28	16/67	24	22/79	28
Addition Algorithms—Timed Test[a]	24	62/37	168	--	--	72/75	96
Subtraction Algorithms--Timed Test[a]	24	25/15	168	--	--	53/55	96
Addition Facts Recall--Speeded Test	12	37/44	84	45/63	72	70/83	84
Subtraction Facts Recall--Speeded Test	12	31/37	84	47/65	72	57/68	84

continued

Appendix C-3 (continued)

Objectives	Numbers of Items	Feb. N=6 f/%	t	April N=6 f/%	5	May N=6 f/%	t
		Cognitive Level 4					
Prerequisite Instructional Objectives							
Numerousness 0-99	2	8/67	12	5/42	12	11/92	12
Ordering, Place Value 0-99	2	2/17	12	9/75	12	3/25	12
Instructional Objectives for the S and A Topics							
Sentence-writing 0-20, 0-99 (multiple choice)	4	9/38	24	15/63	24	15/63	24
Sentence-writing 0-20, 0-99 (free response)	4	6/25	24	14/58	24	17/71	24
Noninstructional Objectives							
Problem-Solving 0-20, 0-99	4	17/71	24	19/79	24	19/79	24
Addition Algorithms--Timed Test[a]	24	61/42	144	—	--	50/69	72
Subtraction Algorithms--Timed Test[a]	24	13/9	144	--	--	42/58	72
Addition Facts Recall--Speeded Test	12	29/40	72	42/58	72	62/86	72
Subtraction Facts Recall--Speeded Test	12	29/40	72	44/61	72	53/74	72

continued

Appendix C-3 (continued)

Objectives	Number of Items	Feb. N=5 f/%	Feb. N=5 t	April N=6 f/%	April N=6 t	May N=6 f/%	May N=6 t
Cognitive Levels 5,6							
Prerequisite Instructional Objectives							
Numerousness 0-99	2	9/90	10	8/67	12	12/100	12
Ordering, Place Value 0-99	2	4/40	10	11/92	12	8/67	12
Instructional Objectives for the S and A Topics							
Sentence-writing 0-20, 0-99 (multiple choice)	4	9/45	20	15/63	24	20/83	24
Sentence-writing 0-20, 0-99 (free response)	4	10/50	20	15/63	24	19/79	24
Noninstructional Objectives							
Problem-Solving 0-20, 0-99	4	15/75	20	21/88	24	22/92	24
Addition Algorithms--Timed Test[a]	24	60/50	120	--	--	112/93	120
Subtraction Algorithms--Timed Test[a]	24	29/24	120	--	--	93/78	120
Addition Facts Recall--Speeded Test	12	35/58	60	61/85	72	66/92	72
Subtraction Facts Recall--Speeded Test	12	33/55	60	62/86	72	59/82	72

[a]This objective was assessed in February for 22 students representing all cognitive levels (N=12, 20, 18, 17) and in May for 12 students at all levels except 2 (N=0, 4, 3, 5). It was not assessed in April.

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